Buyers' Guide and Chemical Exposition Issue

CHEMICAL & METALLURGICAL ENGINEERING

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The Engineer's Contributions to Industry

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CHEMICAL & METALLURGICAL ENGINEERING

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The Theme of This Issue—Increased Production Efficiency

PSYCHOLOGISTS tell us that sustained emotion is harmful and beyond a certain point impossible. That is why a man viewing Niagara for the first time is awed, whereas the bellboys at Hotel Clifton hardly ever glance at the spectacle. We, you, in our relation to the chemical industry are much like the Clifton bellboys with respect to Niagara. Our contact is so close, so continuous, that we are likely to look upon it only in the most casual manner. For this reason it is worth while occasionally to detach ourselves and view the whole spectacle or a part of it with the enthusiasm of a novice. The thrill may not and will not be sustained, but it will have the inestimable value of orienting us anew and lifting us out of the rut of routine.

Such is the purpose of this issue of *Chemical & Metallurgical Engineering*. Speaking in all modesty for ourselves, but with full credit to the excellent authors who have contributed the contents, we think the issue serves the purpose of taking the reader away from the routine of his task and directing his attention in a most inspiring manner to a special topic of undoubted importance.

Why seek to increase the efficiency of our production processes?

Production and distribution, their interrelations and their influence on human affairs, constitute in large measure the problems which our civilization is now facing. Between these two factors there can be no choice as to which is more important. If the world as we know it is to continue to develop along its present paths, then ultimately both of these problems must receive as nearly perfect a solution as is within the compass of human ability. The question of importance between these two factors is one of immediacy.

As the population increases and the free natural resources of the world diminish, the pioneer type of independent existence becomes possible to an ever-decreasing number. More and more we depend on cheap and rapid production of goods—quickly and efficiently distributed —for the maintenance of our well being and happiness.

The problem of distribution must be solved. If it is not, our ability to obtain the necessities and luxuries by which our standard of living and our very civilization are maintained will lessen. If it lessens to any great extent, the whole structure of our life as we know it will tumble about our ears, as it recently did in Russia. Only through efficient, scientifically administered distribution can the spread between the producer and the consumer be kept down. The development of this administrative control is largely a matter of government, and for this reason must unfortunately wait on politics. In the long run, however, the public at large has government under its control and can, when educated to the point of realizing the necessity of good distribution methods, demand and get them.

Efficient distribution, although it may seem extraneous to our main editorial theme, is nevertheless so closely tied up to the problems of production that we have felt justified in giving it some consideration at this time. With this end in view we have included a series of short, poignant messages from leading sales executives outlining their views as to how efficient production can be supported by better directed and more intelligent distribution.

Efficient production is fully as important to our way of life as is good distribution. The advent of the machine made possible a vast extension in quantity and kind of the goods by which mankind lives. Machinery on the farm increased the available food supply, and machinery in the town increased the supply of those goods which the farmers needed and for which they were willing to exchange food. The age-long checks were removed, the doctrine of MALTHUS for the time ceased to operate and the population of the world increased by bounds. Such a situation cannot continue indefinitely. There must come a time when the most strenuous efforts of all workers will not serve to keep up the standard of living requisite to well being, even with the improvements in method and equipment which will without doubt then be available. The limit of exploitation of the earth's resources will eventually be reached and the law of MALTHUS must then operate.

The earth's resources are still ample to keep all in comfort. The scientific knowledge for their development is available. Man's ineptitude alone is responsible for the problems of adequate production which the world now faces and upon the solution of which so largely depend the welfare and contentment of the race and the dissipation of the ugly unrest so prevalent today.

Production need not delay, as distribution must, the solution of its problems. The power to reach these solutions lies today in the hands of the technologists, engineers, executives and owners who control our industries. Every consideration of successful business, the highly competitive market which must be met, the demands of labor and the demands of capital, all these strongly urge them to exercise this power. If those at present in control do not increase the efficiency of production, then their places must be taken by those that will. For the means of effecting this increase in production efficiency are at hand and the lower prices that will result are the first step that must be taken in restoring the balance of our war-tried world.

With these facts in view, we have gathered in this issue the thought of some of the country's industrial leaders on the present industrial situation and their recommendations as to the paths to be followed to reach an improved condition. The articles in which their thoughts are embodied form a message which cannot fail to be of inspiration and benefit to all connected with productive industry—a message of INCREASED PRODUCTION EFFICIENCY.

The Human Factor in Efficient Production

HUMAN EFFORT lies at the very foundation of production, and yet of the entire structure it is the least tangible part. Even in our industries where science and engineering have evaluated machine and process with all the precision of mathematical certainty, there still remains the human element, the unknown quantity, the x in every equation. That intangible something which eventually finds its way into the profits and losses of industry touches on every phase of production, distribution and management. It offers a myriad of problems, many as old as industry itself. But it is in the intricacy of modern business that we find most evidence of its workings, and it is there that we should study it. The age-old problems of employer and employee have so broadened that the manager of today is concerning himself with many questions which a few years ago were regarded as foreign to industry's obligations. Such factors as the health and happiness of the workers, their welfare and safety, physical and mental comfort, housing and sanitation, selection and training—all these are now recognized as just as much the problem of management as those of supervision, wages and hours of work.

But underlying all of this is the fundamental conception of labor—not as a commodity subject to impersonal barter and trade, but as a vital, living force sharing with capital in the ups and downs of industry. When the Secretary of Labor tells us, as he does in this issue, that the American workman is coming to realize his tremendous responsibility to himself, his craft, his industry and his country, Mr. DAVIS is speaking for an enlightened citizenry. And certainly labor must look far to find a more creditable spokesman. Coming to this country as a youngster in a large family of Welsh immigrants, JAMES J. DAVIS began a most unusual career, and yet one that is typically American. He was only 11 when he entered the steel mill to learn his trade as a puddler, and there for 14 years he worked at severest manual labor. Naturally, with such a grounding, the Secretary of Labor looks at industry through the eyes of labor, but not with the bias of the partisan nor the prejudice of the professional organizer. His message on "Labor's Responsibility for Industrial Efficiency," which was written specially for this annual number of *Chemical & Metallurgical Engineering*, sounds the opening note in our editorial appeal for INCREASED PRODUCTION EFFICIENCY. It has been given this position of honor because we regard it as a classic on which labor may well rest its case.

"Wages" is one of the shortest and simplest words of our language, but it is of tremendous connotation. Concretely, it expresses all of the contractual relations existing between employer and employee. HARRINGTON EMERSON, in his contribution on this subject, gets at the very fundamentals on which wage payments are based. In tracing these relations from Biblical to modern times, he derives four great fundamental principles which he holds essential to the ideal wage system.

Labor turnover—what employer is there who hasn't reason to give it thought? PHILIP BRASHER is inclined to believe that excessive labor turnover is resulting in greater loss to the average manufacturer than is the strike or the lockout. But in either case the cause is the same—the lack of harmonious relations between the employer and the employed. Our contributor offers a solution to this problem in just one word—contact.

Health and happiness of the worker are paramount considerations of the thoughtful employer. JOHN S. SHAW'S experience in one of our largest industries leads him to the conviction that the promotion of these factors favorably affects production and costs. To his way of thinking, the manager can profitably spend as much time and money advancing the comfort and contentment of his workers as in the solution of the physical and technical problems of production. Mr. RESNICK, of the Safety Institute of America, would add safety to this category. Although the industrial safety movement had its inception in a purely humanitarian appeal, it has demonstrated over and over again that to safeguard life and limb is to sidestep a costly drain on morale, production and profit. The progressive manufacturer will find in this article many thoughtful suggestions for removing the hazards of production.

A keener sense of one's place in industry and a better understanding of production principles will make any employee more valuable to his employer. But B. M. NUSSBAUM, in his article on industrial training, would concentrate on the foreman, who he believes holds the most strategic position in the plant organization. By teaching these key men to pull together, it is possible to build up a loyalty that will solve many of the problems of management, that will lower costs, eliminate waste and increase production.

Doubtless there are many other problems of production that turn on the human element. But their solution is not radically different from those which we have already advanced. The whole matter can be summed up in no better way than in a single sentence from Secretary DAVIS' message: "The highest efficiency will be reached by that industry in which the employer knows intimately the problems and needs and aspirations of the worker, and in which the worker has a sympathetic understanding of the difficulties and discouragements and purposes of the employer."

Some Economic Angles To Production Efficiency

IN A recent issue of the *American* magazine there appeared an interview by a versatile and pleasing writer, BRUCE BARTON, with a real leader of industrial progress, HENRY DENNISON, president of the Dennison Manufacturing Co. The interview made a profound impression, partly because it stood out in contrast with the more ephemeral material with which it was flanked, but mainly because it set forth in a convincing manner the invaluable asset which the business man can make of statistical economics. As a result of his study of the business cycle and similar economic subjects, Mr. DENNISON showed how he had stabilized his business with respect to booms and depressions. His company ceased buying raw materials in the winter of 1920, even though orders were piling up and the business boom was at its height. A year later when hundreds of companies were taking a staggering and sometimes fatal inventory loss the Dennison Manufacturing Co. had a clean bill of health.

The incident holds its logical lesson for industry in general, and the chemical and related industries in particular. Consequently the suggestions in this issue by ERNEST T. TRIGG, relative to the possibility of eliminating the very high and very low spots in the business cycle, find an appropriate place in a symposium on increased production efficiency. Can the wavering curve of business be made to approach more nearly a horizontal line? If so, employment would be steadier and

one of the most serious evils of our economic system would be mitigated. Mr. TRIGG'S suggestion to undertake construction work, both municipal and private, during periods of depression is essentially logical. At such times material and labor costs will be low and the supply plentiful.

The connection between increased production efficiency and the business cycle is immediate and fundamental. Nothing is so upsetting to production efficiency as irregular production. In a plant working at 100 per cent capacity, the fixed charges—those that do not vary with rate of production, such as rent, taxes, insurance, depreciation, etc.—are a relatively small percentage of the total cost. As production diminishes the ratio of total cost to fixed charges decreases, and finally a point is reached where the total cost exceeds revenue from sales. This subject is admirably developed by Professor RAUTENSTRAUCH in his article on the budget. The graphical determination of the point is amazingly simple if one has accurate costs. And thus we arrive at the crux of the application of economic principles to business—costs, accurate costs—costs which are not biased by any limited point of view, such as sales or production. The development of this theme in its relation to production efficiency is covered in this issue by GEORGE P. COMER, who pleads for a rational interpretation of cost data. We look upon his article as excellent ammunition in the campaign which we have consistently waged to impress chemists with the importance and necessity of accurate cost data.

In conclusion, it is well to remember that although production efficiency is obviously dependent upon the solution of many technical problems, and although happily the welfare of the worker and other human elements have become recognized factors in efficient production, the keystone of success certainly lies in the economic soundness of a business.

Increased Production Efficiency From an Engineering Standpoint

PRODUCTION EFFICIENCY can be increased by bringing into play on the elements of production three kinds of knowledge: engineering science, economic science, and human relations. The influence of these three cannot be considered separately, for they overlap at many points. However, no one man, be he ever so able, can be thoroughly expert in the application to industry of more than a small part of any of these branches of knowledge. The knowledge of many, taken together, must be sought to give us the complete picture.

The engineering phases of increasing production efficiency, those phases concerned with the technology of industry, form an important part of this picture. They deal primarily with the proper utilization of buildings and equipment, utilization in such a way as to obtain maximum production for least cost. The important things to be considered are the design of the plant, the routing and handling of the materials through the plant, the choice and use of the process equipment and the proper application of power to the various operations.

Other factors must be considered which are only in part of an engineering nature, being fully as much concerned with economics or human relations. Often these factors are extremely important from an engineering point of view and have a strong influence on the primary engineering problems of production. Among these perhaps the most important are the lighting, heating and ventilation of the plant; the safety of operating conditions; the standardization of product and operation; and the research work necessary to keep all the foregoing at the best possible level.

In the contributions to this issue will be found much valuable information and many inspiring suggestions as to the engineering means to be employed in increasing production. These contributions are of two types: papers by specialists on the phases of the subject which are their particular concern and short messages from men responsible in the management of different industries. We believe the first category presents an unusual opportunity for the reader to familiarize himself with the basic engineering principles through which the technique of production can be improved, while the second presents the production problems of individual industries and suggests their solution in a manner that cannot fail to be profitable.

The layout of buildings and equipment, the routing of materials through the plant, and the handling of materials in accordance with this routing comprise the most important production problems with which we are now confronted. These three problems must be considered together, and to reach a rational basis of consideration a beginning must be made with the flow-sheet, as A. E. MARSHALL so clearly points out. After the flow-sheet has been established, the routing of the process can be readily determined. This routing forms the starting point for scientific plant design. FRANK D. CHASE shows in his paper on this subject that the important factors in plant engineering are the location, layout, equipment design, finance, operation and management. The bearing of all these factors on the successful operation of a plant should be determined before the plant is built. The material-handling equipment must be chosen on the basis of the routing and the plant layout must fit the exigencies of this equipment. J. G. HATMAN brings before us the fundamental principles on which a chemical plant handling system must be based if its full possibilities are to be realized.

The proper application of power to industry is one of the most important services which the engineer has to perform today. The present tendency is toward the more general use of electricity, and C. B. GIBSON shows us that electric power is power scientifically applied and hence aids the executive in the study of plant problems and leads to more efficient operation, better quality of product and general plant betterment. Steam is the general source of this electric power and in addition has a wide application in the processes of many industries. HERBERT B. REYNOLDS points out in his paper the importance of conserving fuel in the generation of steam power. He feels that generally the power plant is the stepchild of the management, is not understood and for that reason receives much less attention than it profitably should. Power costs should be determined to permit management to know and control this feature of production, realizing thus its best efficiency. Gas is a primary source of heat in many industries and in others is a recognized rival of steam. CARL J. WRIGHT shows how this source of power and heat could be used to advantage more extensively. Gas gives not only increased thermal efficiency but in many cases gives increased quantity and better quality of product.

Among the factors which are not wholly of an engineering nature but which have an important bearing on good engineering in the plant, CHARLES GALLO well points out the advantages to be obtained from good

plant lighting, among which perhaps the most important is that it permits the operators to see clearly and quickly enough to obtain the best results from the equipment. Another means of obtaining the best results from the equipment is brought out in WILLIS H. CARRIER'S thoughtful paper on the value of conditioned air in industry. Safety engineering is generally considered from the point of view of its effect on the personnel, but LOUIS RESNICK'S article on this subject shows that safety of operation also plays an important part in enabling the equipment to function at its best.

Mass production is attained essentially through standardization of product and operation; and for this reason the present active campaign for standardization in industry has a direct bearing on production engineering, for it is by means of mass production that the full advantage of scientific plant engineering is realized. Standardization in chemical industry can be successfully realized only by means of extensive research. C. G. DERICK'S paper on research brings out this fact among many other points of equal importance.

In studying the shorter articles presented by men from the various industries the reader cannot fail to be impressed with the importance of the message which they contain. It avails little to pick out the features of these articles which are of special interest from an engineering point of view. Every reader will profit from a study of this entire symposium. Emphasis may well be given, however, to the point brought out by O. S. SLEEPER, that the road to improvement in process equipment lies through the complete co-operation of chemical manufacturers and equipment makers, and that the progressive manufacturer cannot afford to have any secrets from the man who builds his equipment.

The Eighth Exposition Of Chemical Industries

THE exposition that will open at Grand Central Palace on Sept. 11 will represent the consummation of a year's thought and effort begun when the last one closed a year ago. The orderly arrangement of exhibits will have been assembled for the visitor almost as if by magic, and the carefully planned programs will be carried out with a degree of smoothness and precision that will scarcely be appreciated by those whom they are intended to benefit. Only those who have been directly connected with the preparation of the vast spectacle will have any adequate comprehension of the work involved.

It is doubtful if any technical exposition has grown to the magnitude and enjoyed the degree of popularity that has been attained by the chemical exposition. Essentially technical in its nature, it has nevertheless been able to offer a popular appeal to intelligent people that has undoubtedly done much to create in the mind of the public a sense of the importance of the chemical industry in our national welfare. That it has been possible to increase and sustain this interest for 8 successive years is a tribute not only to the management of the exposition but to the excellence of the exhibits as conceived by those who have made them year after year. They have had a tremendous educational value as well as undoubted commercial and technical importance. Engineers have attended in order to pick up new ideas; college professors have brought their classes for purposes of instruction; and buyers and sellers have even transacted business on the floors of the exposition. All told, it has been a remarkable and ever-increasing success, to which the show for 1922 will be no exception.

Twenty Years of Militant Journalism

WITH the publication of this issue, *Chem. & Met.* rounds out 20 years of growth and service. It was in September, 1902, that *Electrochemical Industry*, as it was then called, was first offered to a friendly but critical group of scientists and industrial leaders who were inaugurating electrochemistry and electrometallurgy in this country. The magazine was conceived in a new spirit of technical literature and born under the favorable auspices of conservative and successful publishing. In the first issue the editor frankly declared an editorial policy "unhampered by precedent" that would enable him to conduct the magazine "along the most advanced lines of modern technical journalism." And "unhampered by precedent" it has been from that day to this.

How well the standards of the founders have been maintained and how nearly they realized their hopes and ambitions are matters of record in twenty-seven volumes of technical literature. That these volumes have been bound and preserved by an unusually large number of subscribers is testimony to a quality of permanence in their value seldom found in current literature. That the journal has reached its present proportions and acknowledged position of importance in the chemical industry is a tribute to its service to reader and advertiser alike.

It is not our purpose here to chronicle the details of 20 years of editorial effort. But a few matters are worth recording. "Unhampered by precedent" the magazine did not hesitate to render service whenever and wherever opportunity offered. This led to growth and expansion. Dr. ROEBER loved to refer to the paper as an insurgent publication, and in September, 1912, on its tenth anniversary he saluted his readers under the caption "Ten Years of an Insurgent Engineering Journal." And the record disclosed a spirit of service and independence that readily accounts for the journal's success and progress. At that time its name had already been twice changed, as its editorial scope and contents were modified to serve an expanding field. And since then equally important changes have been made, all dictated by the demands of the times. Once more the name was changed. Once more "unhampered by precedent" the monthly magazine became an equally successful semi-monthly and finally assumed unquestioned leadership in its field by weekly publication.

Thus we arrive at our present status as an exponent of technology in industry—the application of the principles of science, mathematics and engineering to industrial processes. Once more "unhampered by precedent" we have conceived an editorial scope that covers the broad range of chemical and related industries in which the fundamental processes of chemical engineering are applied. On this basis we serve the ceramist and the soapmaker, the producer of sugar and the manufacturer of paper and pulp, the refiner of petroleum and the burner of lime and cement, the strictly chemical industries and the related manufacture of coal and wood byproducts, fertilizers, paint and varnish, rubber, leather, food and animal products. And hand in hand with this service to technology has developed a fighting spirit of support for the chemical industry in our national life and welfare. The insurgency of a decade ago has begotten the militancy of today. What the future holds we cannot tell, but whatever it be it will still be met "unhampered by precedent."

Program of the Exposition

Four Technical Societies and One Trade Association to Hold Sessions for Reading and Discussion of Papers—Wide Range of Industrial Processes Illustrated by an Excellent Selection of Motion Pictures

ONE of the novel features of the daily technical programs at the Eighth National Exposition of Chemical Industries will be the first session of the recently organized Technical Photographic and Microscopical Society. This organization is made up of technologists in all industries in which photography, microscopy and photomicography play an important part.

Other organizations that will hold their regular sessions at Grand Central Palace during Exposition Week are the Technical Association of the Pulp and Paper Industry, the American Ceramic Society and the New York Section of the American Chemical Society.

The Synthetic Organic Chemical Manufacturers Association of the United States will hold a session on Tuesday afternoon and there will also be a general meeting at which chemical engineering problems will be discussed.

The motion picture program this year comprises an unusually good selection of films on industrial subjects that will have a strong educational value.

Among the general addresses none will arouse more interest than that scheduled for Monday evening, when Wayne B. Wheeler, counsel for the Anti-Saloon League, will speak on "The Attitude of the Anti-Saloon League Toward Industrial Alcohol."

The detailed program follows:

Program of Speakers and Meetings

All in the Meeting Auditorium—Fourth Floor.

MONDAY, SEPT. 11.

8 p.m.—Opening address by Charles H. Herty, chairman, Exposition Committee.

Wayne B. Wheeler, counsel Anti-Saloon League, "The Attitude of the Anti-Saloon League Toward Industrial Alcohol."

Miss Lida Hafford, director, general headquarters, General Federation of Women's Clubs, "Woman's Interest in Chemistry in America."

TUESDAY, SEPT. 12.

2 p.m.—Meeting of the Synthetic Organic Chemical Manufacturers Association of the U. S.

8 p.m.—E. H. Hale (Liquid Carbonic Co.), "Manufacture, Properties and Application of Carbon Dioxide."

P. W. Heath (Liquid Carbonic Co.), "Using Carbon Dioxide in Ice Cream."

C. R. DeLong (Chemical Division, U. S. Department of Commerce), "How the Department of Commerce Can Serve the Chemical Industry."

WEDNESDAY, SEPT. 13

Pulp and Paper Day

2 p.m.—Meeting, Technical Association of Pulp and Paper Industry, George E. Williamson, chairman.

W. C. Edge (Paul B. Huyette Co.), "Safety and Efficiency Appliances for the Boiler Plant."

E. J. Trimbey (Trimbey Machine Works), "Trimbey and Tibbitts Proportioning and Metering System for Paper Stock."

George L. Dickey (Industrial Filtration Corp.), "Rotary Filters for Washing of Paper Pulp and for Filtering and Washing Caustic Lime Mud." (Illustrated.)

H. A. Morrison (Oliver Continuous Filter Co.), "Efficiencies and Economies in Washing Black Liquor From Digested Soda and Sulphate Stock."

L. D. Mills (The Merrill Co.), "The Merco Nordstrom Plug Valve."

H. S. Thayer (Atlas Electric Devices Co.), "Testing Colored Materials for Fastness to Light."

A. E. Campbell (The Schaeffer & Budenberg Mfg. Co.), "Instruments for Promoting Efficiency in the Paper Mill."

L. G. Bean (The Bristol Co.), "Application of Recording Instruments in Pulp and Paper Industry."

C. C. Phelps (Uehling Instrument Co.), "The CO_2 Record of Combustion Efficiency."

Harry Carlson (Sandvik Steel, Inc.), "Steel Belts and Their Application to the Solution of Conveying Problems."

H. Austin (Ernest Scott & Co.), "Scott Evaporator as Used in the Pulp Mill for Recovering Soda From Spent Liquors."

L. G. Chase (Yarnall-Waring Co.), "The V-Notch Meter and Its Application to the Paper Mill."

W. D. Mount (Glamorgan Pipe & Foundry Co.), "Continuous Causticizing With Lime Recovery and Re-use."

Jerome D. Stein (Grinnell Co.), "The Grinnell Drier Applied to Wall-Paper and Coated Paper."

L. Mann (National Aniline & Chemical Co.), "The Proper Selection and Application of Dyes for Paper."

THURSDAY, SEPT. 14

2 p.m.—Meeting, Technical Photographic and Microscopical Society. (Meeting will take place in Motion Picture Room.) James McDowell, chairman.

Miss Eloise Gerry and Dr. E. M. Diemer (Forest Products Laboratory, Madison, Wis.), "Photomicrography in Pulp and Paper Research Problems."

Henry Green (New Jersey Zinc Co., Palmerton, Pa.), "The Photomicroscopy of Paint and Rubber Pigments."

Dominic S. Mungillo (Craftsmen's Film Laboratory, New York), "How Motion Pictures Are Finished."

Clarence W. Gibbs (Victor Animatograph Co., New York), "Mechanics of Motion Picture Apparatus."

Alfred B. Hitchins, Ph.D. F.C.S. (director Ansco Research Laboratory, Ansco Co., Binghamton, N. Y.), "The Motion Picture as an Aid to Industry."

Guido E. Daub (A. F. Gallun Sons Co., Milwaukee, Wis.), "Microscopy in Leather Tanning."

Albert H. Grimshaw (Textile School, New Bedford, Mass.), "Use of the Microscope in Textile Work."

Philip O. Gravelle (South Orange), "Protozoa and Rotifers: Studies in Microscopic Animal Life." (Illustrated by motion pictures.)

8 p.m.—M. L. Crossley (Colco Chemical Co.), "The Colors That Please Us."

FRIDAY, SEPT. 15

Ceramic Day

2 p.m.—Meeting, American Ceramic Society.

8 p.m.—Meeting, New York Section American Chemical Society. Martin H. Ittner, chairman.

W. D. Collins (U. S. Geological Survey), "Moderation in Standardization."

N. F. Harriman (U. S. Bureau of Standards), "Standardization From the Consumer's Point of View."

I. G. Jennings (Glass Container Association), "Discussion of the Reasons for the Varieties of Shapes and Sizes."

J. M. Roberts (secretary of the Apparatus Manufacturers' Association of the United States), "What Has Been Accomplished in the Standardization of Scientific Apparatus."

Ross C. Purdy (secretary, American Ceramic Society and chairman of committee on refractories of the American Society of Testing Materials), "Standardization of Fire-clays and Refractories."

Emerson C. Poste (Elyria Enameled Products Co.), "Standardization of Enameled Wares for Chemical Purposes."

William A. Durgin (Division of Simplified Practice, Department of Commerce), "Standardization."

Motion Picture Program

All in the Motion Picture Room, Fourth Floor

TUESDAY, SEPT. 12

2 p.m.—"The Story of Sulphur" (2 reels), Courtesy, U. S. Bureau of Mines and Texas Gulf Sulphur Co.

"Dust Explosions" (1 reel), Courtesy, U. S. Bureau of Chemistry.

"Protecting Buildings Against Lightning" (1 reel), Courtesy, Baltimore Copper Works.

"The Story of Asbestos" (4 reels), Courtesy, Johns-Manville Co.

"Nickel and Copper Mining, Smelting and Refining" (3 reels), Courtesy, International Nickel Co. (Speaker.)

"Recovering Values From Fume and Smoke" (1 reel), Courtesy, U. S. Bureau of Mines and Research Corporation.

7:30 p.m.—"The Story of Natural Gas" (4 reels), Courtesy, U. S. Bureau of Mines.

"Extinguishing the Largest Oil Fire in the History of Casper, Wyo." (1 reel), Courtesy, Foamite-Childs Corporation.

"The Romance of Cotton" (1 reel), illustrated with address by David Wesson of Southern Cotton Oil Co.

"The Story of Air Reduction" (4 reels), Courtesy, U. S. Bureau of Mines.

WEDNESDAY, SEPT. 13

2 p.m.—"The Story of Heavy Excavating Machinery" (4 reels), Courtesy, U. S. Bureau of Mines.

"The Story of Abrasives" (4 reels), Courtesy, U. S. Bureau of Mines and the Carborundum Co.

"Prospecting for Gold in Northern Ontario," and "Assaying for Gold in Northern Ontario," (3 reels), Courtesy, Ontario Department of Mines.

7:30 p.m.—"The Manufacture of Newsprint Paper at the Spanish River Pulp & Paper Co. Mills in Ontario" (8 reels), Courtesy, The G. H. Mead Co.

"Barrel Making in America" (2 reels), Courtesy, Lucas E. Moore Stave Co.

"The All-weather Fire Extinguisher That Won't Freeze" and "An Industrial Firefoam Sprinkler System" (1 reel), Courtesy, Foamite-Childs Corporations.

THURSDAY, SEPT. 14

2 p.m.—Room occupied by meeting of T.A.P.P.I.

7:30 p.m.—"Mexican Petroleum" (4 reels), Courtesy, U. S. Bureau of Mines.

"Extinguishing the Largest Oil Fire in the History of Casper, Wyo." (1 reel), "Fire-Extinguishing Tests on Blazing Oil Tanks at Port Arthur, Tex. (1 reel), Courtesy, Foamite-Childs Corporation.

"Protozoa and Rotifers: Studies in Microscopic Animal Life" (1 reel).

"Inspiration: One of the World's Great Copper Mines" (3 reels), Courtesy, U. S. Bureau of Mines.

"How Motion Pictures Are Finished" (1 reel), Courtesy, Craftsman Films, Inc.

FRIDAY, SEPT. 15

2 p.m.—"Prospecting for Gold in Northern Ontario" and "Assaying for Gold in Northern Ontario" (3 reels), Courtesy, Ontario Department of Mines.

"Inspiration: One of the World's Great Copper Mines" (3 reels), Courtesy, U. S. Bureau of Mines.

"Nickel and Copper Mining, Smelting and Refining" (3 reels), Courtesy, International Nickel Co. (Speaker.)

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"The Story of Abrasives" (4 reels), Courtesy, U. S. Bureal of Mines and the Carborundum Co.

"Barrel Making in America" (2 reels), Courtesy, Lucas E. Moore Stave Co.

"Dust Explosions" (1 reel), Courtesy, U. S. Bureau of Chemistry.

SATURDAY, SEPT. 16

2 p.m.—"The Story of Air Reduction" (4 reels), Courtesy, U. S. Bureau of Mines.

"The Story of Asbestos" (4 reels), Courtesy, Johns-Manville Co.

"The Story of Sulphur (2 reels), Courtesy, U. S. Bureau of Mines and Texas Gulf Sulphur Co.

"Fire-Extinguishing Tests on Blazing Oil Tanks at Port Arthur, Tex." (1 reel), and "Extinguishing the Largest Oil Fire in the History of Casper, Wyo." (1 reel), Courtesy, Foamite-Childs Corporation.

7:30 p.m.—"Nickel and Copper Mining, Smelting and Refining" (3 reels), Courtesy, International Nickel Co. (Speaker.)

"Protecting Buildings Against Lightning" (1 reel), Courtesy, Baltimore Copper Works.

"The Romance of Cotton" (1 reel), illustrated with address by David Wesson of Southern Cotton Oil Co.

"Recovering Values From Fume and Smoke" (1 reel), Courtesy, U. S. Bureau of Mines and Research Corporation.

"The Manufacture of Newsprint Paper at the Spanish River Pulp & Paper Co. Mills in Ontario" (8 reels), Courtesy, The G. H. Mead Co.

Classified List of Exhibitors

A List for Ready Reference From Which the Busy Reader Can Quickly Ascertain the Names of Those Companies Exhibiting the Special Products in Which He Is Most Interested

IN AN EFFORT to render better service both to the readers of *Chem. & Met.* and the exhibitors at the exposition, a new method of presentation has been adopted this year. Hitherto we have given an alphabetical list of exhibitors with a brief explanatory statement of their exhibits. This has not been wholly satisfactory, because readers were more interested in the material exhibited than in the concerns exhibiting.

Accordingly this year we have classified the exhibitors according to the character of their exhibits and have listed the companies under classifications that will enable the reader to see at a glance who is exhibiting the things in which he is most interested.

No attempt has been made to give the booth number of the various exhibitors, as this will be more conveniently ascertained by reference to the pocket-size program that we shall distribute at the exposition. The principal purpose of the present classification is to enable the reader to determine at leisure those things to which he will prefer to devote the most of his time.

Abrasives:
The Carborundum Co.
Norton Co.

Absorption Equipment:
Silica Gel Corp.

Acid Plants and Equipment:
United Lead Co.

Acid-Resisting Materials:
Bethlehem Foundry & Machine Co.
The Duriron Co., Inc.
Electro-Chemical Supply & Engineering Co.
General Ceramics Co.
General Filtration Co., Inc.
Haynes Stellite Co.
Maurice A. Knight
Luzerne Rubber Co.
Johns-Manville, Inc.
J. L. Mott Iron Works
Nitrose Co.
Westinghouse Elec. & Mfg. Co.

Agitators:
Bethlehem Foundry & Machine Co.
The Dorr Co.
General Ceramics Co.
Hunter Dry Kiln Co.
F. J. Stokes Machine Co.
The Carrier Engineering Co.
W. L. Fleisher & Co., Inc.

Alcohol:
Alcohol Warehouse Corp.
U. S. Industrial Alcohol Co.

Alloys:
American Brass Co.
American Manganese Bronze Co.
Anaconda Copper Mining Co.
Anaconda Rolling Mill Dept.
Aterite Co., Inc.
Baker & Co., Inc.
British-America Nickel Corp., Ltd.
Calorizing Co. of Pittsburgh
The Duriron Co., Inc.
Haynes Stellite Co.
Hoyt Metal Co.
International Nickel Co.
International Smelting Co.
Monel Metal Products Co.
Tuc-Tur Metal Corp.
United Metals Selling Co.
York Metal & Alloys Co.

Asbestos:
Johns-Manville, Inc.
Powhattan Mining Co.

Asphalt:
The Barber Asphalt Co.

Associations:
National Lime Association
Talc & Soapstone Producers Assn.

Autoclaves:
M. W. Kellogg Co.

Automatic Machinery:
Economic Machinery Co.
Edward Ermold Co.
Karl Kiefer Machine Co.
Mohan & Co., Inc.
Standard Sealing Equipment Corp.
Trimbey Machine Works
Wallace & Tiernan Co., Inc.

Bags:
Arkell Safety Bag Co.

Balances:
Christian Becker, Inc.
Palo Co.
Voland & Sons

Bakelite:
The Bakelite Corp.
The General Bakelite Co.

Barrels and Drums:
The Associated Cooperage Industries of America
Chess & Wymond
The Cleveland Cooperage Co.
B. & A. D. Fessenden Co.
Pioneer Cooperage Co.
Pressed Steel Tank Co.
Seymour & Peck Co.

Belting:
R. & J. Dick Co., Inc.

Blowers and Fans:
Abbé Engineering Co.
Beach-Russ Co.
The Duriron Co., Inc.
General Ceramics Co.
Schutte & Koerting Co.
B. F. Sturtevant Co.

Books, Technical:
P. Blakiston's Son & Co.
J. B. Lippincott Co.
D. Van Nostrand Co.
John Wiley & Sons, Inc.
H. W. Wilson Co.

Burners:
Glens Falls Machine Works
Macleod Co.
Surface Combustion Co.
Trimbey Machine Works
Will Corp.

Canada:
Dominion Water Power Branch
Forest Products Labs. of Canada
Ontario Dept. of Mines

Carbon Products:
Barnebey Cheney Engrg. Co.
Carbrox Co., Inc.
Darco Sales Corp.
Industrial Chemical Co.

Centrifugals:
De Laval Separator Co.
Fletcher Works
Sharples Specialty Co., Inc.
Tolhurst Machine Works

Chemical Engineers:
H. E. Jacoby
Petri & Dorr

Chemical Plant Equipment:
Allis-Chalmers Mfg. Co., Inc.
A. J. Becker
Benzine Condensation Co.
Buffalo Foundry & Machine Co.
Builders Iron Foundry
Clipper Belt Lacer Co.
Corning Glass Works
Crane Co.
Crane Packing Co.
J. P. Devine Co.
Electro Bleaching Gas Co.
The Elyria Enameled Products Co.
Filtration Engineers, Inc.
General Ceramics Co.
Glamorgan Pipe & Foundry Co.
Glens Falls Machine Works
Haynes Stellite Co.
International Nickel Co.
Henry E. Jacoby
Janney, Steinmetz & Co.
M. W. Kellogg Co.
Maurice A. Knight
L. O. Koven & Brother
La Bour Co.
Monel Metal Products Co.
J. L. Mott Iron Works
Niagara Alkali Co.
Perry & Webster, Inc.
Pfaudler Co.
Ernest Scott & Co.
Charles E. Sholes
Silica Gel Corp.
Sowers Mfg. Co.
Stuart & Peterson Co.
Trimbey Machine Works
United Lead Co.

Chemicals:
American Aniline Products, Inc.
American Cyanamid Co.
Apex Chemical Co., Inc.
Avery Rock Salt Mining Co.
J. T. Baker Chemical Co.
Chemical Service & Sales Corp.
The Cleveland-Cliffs Iron Co.
Commercial Solvents Corp.
The Davison Chemical Co.
Eimer & Amend
Electro Bleaching Gas Co.
Federal Phosphorus Co.
Heyden Chemical Company of America, Inc.
Innis, Speiden & Co.
International Nickel Co.
International Salt Co. of N. Y.
Isco-Bautz Co.
Isco Chemical Co.
A. Klipstein & Co.
Lindsay Light Co.
Liquid Carbonic Co.
Mallinckrodt Chemical Works
Mathieson Alkali Works, Inc.
Merrimac Chemical Co.
Miner Laboratories
Monel Metal Products Co.
National Aniline & Chemical Co.
National Rosin Oil & Size Co.
Niagara Alkali Co.
Nitrogen Corp.
Pennsylvania Salt Co.
Perth Amboy Chemical Co.
Philadelphia Quartz Co.
Powers-Weightman-Rosengarten Co.
Rhodia Chemical Co.
Roessler & Hasslacher Chemical Co.
Southern Agricultural Chemical Corp.
Southern Cotton Oil Co.
Stein, Hall & Co., Inc.
Takamine Commercial Corp.
Takamine Laboratory, Inc.
Chas. S. Tanner Co.
Tennessee Copper Co.
U. S. Industrial Alcohol Co.
U. S. Industrial Chemical Co.
U. S. Radium Corp.
Wilbur White Chemical Co.
Will Corp.
Zinsser & Co.

Chemical Stoneware:
General Ceramics Co.
Maurice A. Knight

Clarifiers:
Petri & Dorr

Classifiers:
The Dorr Co.

Coal-Tar Products:
The Barrett Co.

Coil Pipe:
Whitlock Coil Pipe Co.

Coke Ovens:
Foundation Oven Corp.
Koppers Co.
Seaboard By-Products Coke Co.

Combustion Apparatus:
Mono. Corp of America
Uehling Instrument Co.

Combustion Engineering:
Surface Combustion Co.

Compressors:
Beach-Russ Co.
Nash Engineering Co.
Yarnall-Waring Co.

Concrete Hardening and Waterproofing:
Anti-Hydro Waterproofing Co.

Condensers:
Benzine Condensation Co.

Consultants:
Curt Bredt

Containers:
American Welding Co.
Arkell Safety Bag Co.
The Associated Cooperage Industries of America
Chess & Wymond
The Cleveland Cooperage Co.
The Container Club
Diamond State Fibre Co.
B. & A. D. Fessenden Co.
Janney, Steinmetz & Co.
Liquid Carbonic Co.
Newark Paraffine & Parchment Paper
Seymour & Peck Co.

Conveying Equipment:
The Dow Co.
Karl Kiefer Machine Co.
Sandvik Steel, Inc.

Crushing and Grinding Equipment:
Builders Iron Foundry
J. H. Day Co.
Hardinge Co.
Sturtevant Mill Co.

Distillation Equipment:
M. W. Kellogg Co.
Koppers Co.
F. J. Stokes Machine Co.

Drying Equipment:
Buffalo Foundry & Machine Co.
J. P. Devine Co.
Filtration Engineers, Inc.
W. L. Fleisher & Co., Inc.
Grinnell Co.
Hunter Dry Kiln Co.
Industrial Waste Products Corp.
Proctor & Schwartz, Inc.
Ruggles-Coles Engineering Co

M. W. Kellogg Co.
Lead Lined Iron Pipe Co.
United Lead Co.
Wheeler Condenser & Engineering Co.
Whitlock Coil Pipe Co.

Platinum:
Baker & Co., Inc.

Porcelain:
Coors Porcelain Co.

Power Plant Equipment and Supplies:
Armstrong Machine Works
Crane Co.
Crane Packing Co.
Jos. W. Hays Corp.
Paul B. Huyette Co.
Lunkenheimer Co.
Nitrose Co.
S. Obermayer Co.
Quigley Furnace Specialties Co.
Reliance Gauge Column Co.
Roto Co.
Sarco Co., Inc.
C. J. Tagliabue Mfg. Co.
Templeton Mfg. Co.
Wheeler Condenser & Engrg. Co.
Whitlock Coil Pipe Co.

Power Transmission Equipment:
Clipper Belt Lacer Co.
R. & J. Dick Co., Inc.
Morse Chain Co.
Smith & Serrell

Publications:
The American Dyestuff Reporter
The American Perfumer and Essential Oil Review
Canadian Chemistry & Metallurgy
Canadian Fisherman
Canadian Mining Journal
Canadian Textile Journal
Chemical Age
Chemical and Metallurgical Engineering
Chemical Catalog Co., Inc.
Chemical Color & Oil Record
Color Trade Journal
Combustion
Drug & Chemical Markets
Fertilizer Green Book
Industrial Arts Index
Iron and Steel of Canada
Journal of Commerce (Canadian)
Journal of Commerce (N. Y.)
Manufacturers Record
N. Y. Commercial
Oil, Paint & Drug Reporter
Paper Mill & Wood Pulp News
Pulp & Paper
Magazine of Canada
Textiles
Textile World
Thomas Publishing Co.

Pulverized Fuel Equipment:
K-B Pulverizer Co., Inc.

Pulverizers:
Abbé Engineering Co.
Hardinge Co.
K-B Pulverizer Co., Inc.
Provost Engineering Corp.
Raymond Bros. Impact Pulverizer Co.
Sturtevant Mill Co.

Pumps:
Abbé Engineering Co.
American Hard Rubber Co.
American Steam Pump Co.
Beach-Russ Co.
Blackmer Rotary Pump Co.
Buffalo Foundry & Machine Co.
Chemical Equipment Co.
The Chemical Pump & Valve Co.
J. P. Devine Co.
The Dorr Co.
The Duriron Co., Inc.
General Ceramics Co.
Huhn Mfg. Co.
Karl Kiefer Machine Co.
La Bour Co.
Lunkenheimer Co.
Nash Engineering Co.
Nassau Valve & Pump Corp.
Oliver Continuous Filter Co.
Provost Engineering Corp.
Schutte & Koerting Co.
F. J. Stokes Machine Co.
United Lead Co.
Wheeler Condenser & Engrg. Co.

Pyrometers:
The Brown Instrument Co.
Charles Engelhard, Inc.
Leeds & Northrup Co.
Schaeffer & Budenberg Mfg. Co.
Thwing Instrument Co.
Wilson-Maeulen Co.

Recording Instruments:
Bailey Meter Co.
The Bristol Co.
The Brown Instrument Co.
The Foxboro Co., Inc.
Jos. W. Hays Corp.
Paul B. Huyette Co.
Leeds & Northrup Co.
Mono. Corp. of America
Schaeffer & Budenberg Mfg. Co.
C. J. Tagliabue Mfg. Co.
Thwing Instrument Co.
Uehling Instrument Co.
Wilson-Maeulen Co.
Yarnall-Waring Co.

Refractories:
Calorizing Co. of Pittsburgh
The Carborundum Co.
Johns-Manville, Inc.
Norton Co.
Quigley Furnace Specialties Co.

Refrigerating Equipment:
Silica Gel Corp.
Whitlock Coil Pipe Co.

Rubber Products:
American Hard Rubber Co.
Luzerne Rubber Co.

Safety Devices:
Burrell Technical Supply Co.
Irving Iron Works Co.
Mine Safety Appliances Co.
U. S. Bureau of Mines
Willson Goggles, Inc.

Salt:
Avery Rock Salt Mining Co.
International Salt Co. of N. Y.
Myles Salt Co.
Pennsylvania Salt Co.

Scientific Instruments:
Bausch & Lomb Optical Co.
Cooper Hewitt Electric Co.
Eimer & Amend
Leeds & Northrup Co.
Palo Co.
Pyrolectric Instrument Co.
R. U. V. Co., Inc.
C. J. Tagliabue Mfg. Co
Thwing Instrument Co.
Victor X-Ray Corp.
Weinhagan & Hespe
Will Corp.
Wilson-Maeulen Co.

Screens:
J. H. Day Co.
Newark Wire Cloth Co.
Sturtevant Mill Co.
W. S. Tyler Co.

Scrubbers:
The American Chemical Machinery Company
Benzine Condensation Co.

Shipping Room Equipment:
W. H. Alexander
Ideal Stencil Machine Co.

Societies:
American Ceramic Society
American Chemical Society
Chemists' Club

Southern Resources:
Southern Railway System

Spray Systems:
W. L. Fleisher & Co., Inc.
Industrial Waste Products Corp.
Macleod Co.
Schutte & Koerting Co.
Yarnall-Waring Co.

Steam Appliances:
Armstrong Machine Works
Crane Co.
Crane Packing Co.
Paulsen Spence Co.
C. J. Tagliabue Mfg. Co.
Templeton Mfg. Co.
Wheeler Condenser & Engrg. Co.

Stoneware:
General Ceramics Co.

Sulphur:
The Freeport Sulphur Co.
Texas Gulf Sulphur Co.
Union Sulphur Co.

Talc & Soapstone:
Talc & Soapstone Producers Assoc.

Tanks:
American Hard Rubber Co.
Atlantic Tank & Barrel Corp.
Beckley Perforating Co.
The Elyria Enameled Products Co.
Janney, Steinmetz & Co.
New England Tank & Tower Co.
Pfaudler Co.
Charles E. Sholes

Temperature Apparatus:
Charles Engelhard, Inc.
The Foxboro Co., Inc.
Moto Meter Co., Inc.
Sarco Co., Inc.
C. J. Tagliabue Mfg. Co.

Testing Apparatus:
Atlas Electric Devices Co.

Thermometers:
American Steam Gauge & Valve Manufacturing Co.
The Brown Instrument Co.
Eimer & Amend
Charles Engelhard, Inc.
The Foxboro Co., Inc.
Moto Meter Co., Inc.
Sarco Co., Inc.
Schaeffer & Budenberg Mfg. Co.
C. J. Tagliabue Mfg. Co.
Thwing Instrument Co.
Weinhagen & Hespe
Wilson-Maeulen Co.

Thickeners:
The Dorr Co.

Trucks & Tractors:
Baker R. & L. New York Corp.
Revolvator Co.

Valves:
America Steam Gauge & Valve Mfg. Co.
Aterite Co., Inc.
A. W. Cash Co.
Chemical Equipment Co.
The Chemical Pump & Valve Co.
Crane Co.
The Duriron Co., Inc.
Everlasting Valve Co.
Kelly Valve Co.
Lead Lined Iron Pipe Co.
Liquid Carbonic Co.
Lunkenheimer Co.
Manning, Maxwell & Moore
Merrill Co.
Nassau Valve & Pump Corp.
Schutte & Koerting Co.
Simplex Valve & Meter Co.
Paulsen Spence Co.
United Lead Co.
Wallace & Tiernan Co., Inc.

Waterproofing:
Apex Chemical Co., Inc.

Water Purification:
Cooper Hewitt Electric Co.
Permutit Co.
R. U. V. Co.
Wallace & Tiernan Co., Inc.

Welding:
American Welding Co.
General Electric Co.

Labor's Responsibility for Industrial Efficiency

By James J. Davis
Secretary of Labor

THE word efficiency has come to be looked upon as somewhat of a fetish in our modern industrial life. To many of us it conjures up bespectacled experts, armed with vast documents and charts, who speak of plats, and peaks, and depressions, and index numbers and curves.

But experts are as experts do. Many times we need them sorely. Sometimes, however, I am inclined to throw up my hands and say, "Let us have a little less efficiency and a little more common sense."

For when we embark on the wide sea of mathematical formulas and seek to index the power of every human cog in the industrial machine, there are too many opportunities for us to overlook some vital factor in our calculations. We are likely to think a little too much in terms of figures, and a little too little in terms of manhood. For behind all of the calculated niceties of mathematically charted efficiency lies the human factor, and no mathematician since Euclid has yet been able to reduce humankind to exact arithmetic. After you have reduced every industrial operation to formulas, you have behind them always the algebraic unknown quantity, *x*, humankind.

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James J. Davis
Secretary of Labor

Ultimately, efficiency in industry today rests with labor. The American workman bears upon his shoulders a heavy responsibility to himself, his craft, his industry and his country. For upon him depends, in large measure, the quantity and quality of the nation's production of marketable goods, the index and basis of

prosperity for the individual, the community, the industry and the country. In the work that lies before the hands of the workman is day by day the fate of himself, his employer and the great consuming public that waits on his products. If he falters, no matter what the cause, the result is felt by all dependent on his labor.

More and more, labor in America is coming to realize the tremendous responsibility which rests upon it and the certainty with which it faces disaster unless it accepts and discharges that responsibility. Just as the modern employer has come to realize that he must pay his labor a wage that is more than merely enough to provide him with food, clothing and shelter, the workman is facing his duty to himself and society. The employer who is abreast of the times knows that his workers, and the workers of every other employer, must receive not only a living wage but a saving and buying wage. He knows that the 40,000,000 gainfully employed in America provide out of their wage surplus the vast buying power of America upon which all industry is dependent and without which there can be no prosperity in the land. The workman is learning that to earn a saving wage he must deliver an honest day's work in order that the industry which supports him and his may endure and prosper.

THERE can be no excuse for the worker who shirks on the job, who fails to give to his employer the honest best that is in him. The laboring man who accepts his wage and deliberately slows down his efforts is no better than the bandit who with revolver and jimmy enters the employer's office at midnight and loots the safe. He is taking what does not belong to him. He is doing injustice to himself, his employer and his fellow workers. He is jeopardizing the prosperity of every individual who is touched by his work. I am inclined to think there are few of this type of worker in American industry. I am convinced there are not many who have the point of view of the workman who was approached by an exasperated foreman with the reprimand:

"Here, John, what's the matter? Don't you see that the man beside you is doing three times as much work as you are?"

"I know," was the reply, "I've spoken to him about it half a dozen times, but he doesn't pay any attention to me."

THE greatest need in America is industrial peace. Without it we cannot have our highest production, and without our highest production we cannot bring the nation to its highest prosperity. Industrial warfare, with its constant interruption of production, is the greatest enemy to efficiency in production. To end industrial warfare we need understanding and co-operation between the men who manage industry and the men whose labor makes industry possible. The highest efficiency is reached by that industry in which the employer knows intimately the problems and needs and aspirations of the workers and in which the worker has a sympathetic understanding of the difficulties and discouragements and purposes of the employer. Many of our present-day industrial difficulties were unknown in the days when industry, organized on a much smaller scale, permitted closer personal relations between the men who managed industry and the men who worked in it. The successful surmounting of these difficulties lies in developing some system whereby that close personal relationship may be restored or some adequate substitute found for it.

WE HEAR much talk of man's inhumanity to man in industry, but every man in his personal relationship is essentially human. Inhumanity, in the majority of cases, arises from ignorance.

Efficiency in industry, then, turns largely on the human factor. The human relationships in industry call for a more intimate knowledge among employers of their workers and their problems and for a wider appreciation among workers of the difficulties and aims of their employers. With a closer relationship between employer and employee, a wider knowledge of the problems confronting each, we may look toward the inauguration of a real Golden Rule in industry, that will bring efficiency to its highest point.

Washington, D. C.

Increased Production Efficiency Means Good Material Handling

The Material-Handling Problem in the Chemical Plant—Analysis of This Problem and Some Suggestions Toward Its Solution—Advantages Derived From Good Material-Handling Methods

By J. G. Hatman
Material-Handling Section, American Society Mechanical Engineers
Production Engineer, Frankford (Pa.) Plant, The Barrett Co.

THE majority of chemical plants in the United States are additions to existing industries. During and just prior to the war our national chemical industry knew an enormous expansion. In the rush of this building program conditions were more or less chaotic. Production at any cost was the absolute need of the times; and there was no opportunity, and little inclination, to consider the means by which this production could be attained in an efficient and economical manner.

Other plants besides these war plants existed, but they had been built in days of little competition and there had been no incentive for their owners to adopt the most efficient means and machinery of production. For this reason we find practically all chemical plants today in serious need of effecting reductions in their production costs, for on these reductions depends their ability to meet the keen competition of crowded market and low demand—depends, in fact, their continued existence.

Means by Which Costs May Be Reduced

The three essential elements of a manufacturing concern are buildings, equipment and personnel. When we have the best possible in each of these three divisions —properly co-ordinated by a sane and efficient management—we have the ideal in organization and, *per se*, the lowest possible production costs.

Perhaps perfection in any one of these three elements, or in the management that controls them, is unobtainable; but the approach to perfection is open to all, and it remains only to study these various elements and determine in what way the approach shall be made. Elsewhere in this issue the subjects of buildings, personnel and management are treated. Here the attempt will be made to point out what seems to the writer the most important way in which equipment can be treated with a view to lowering costs and increasing efficiency.

The Equipment Problem in the Chemical Plant

Modern manufacturing equipment consists of two main divisions: equipment which performs the various operations in the manufacture, and equipment which serves to bring the material to and take it away from machines of this first division. These two classes may be called—in their simplest terms—process equipment and material-handling equipment.

The equipment problem is, therefore, twofold. It is necessary to have the best possible process equipment, adapted to the particular circumstances of the given plant, that may be procured. It is necessary to have such material-handling equipment as will enable all the other elements involved—the buildings, the process equipment, the personnel and the management—to realize each its best performance.

The Status of Process Equipment

Process equipment is a matter of development. At any given time the manufacturer has available for his use equipment which represents the best results of research and invention in his particular line. In some instances it may, in the light of information in the manufacturer's hands, be possible to make improvements in this equipment which will render it more efficient and thus lower production costs. Also, the function of management, in housing, arranging and controlling the operation of the equipment, can do much to render it efficient.

The great means, however, for improving the efficiency of industry through the process equipment lies in the development of improvements through research and invention. This is a matter of time. Constantly new items appear. The alert manufacturer, who keeps his eye on the market and adopts the best of this equipment suited to his needs and applies it in the most efficient manner, is doing the best that can be done toward realizing on the process equipment itself.

The Status of Material-Handling Equipment

The material-handling equipment, however, presents an entirely different range of possibilities to the management which seeks to reduce costs. Here we have an almost infinite variety of appliances—well designed and thoroughly tested. While improvements will no doubt occur from time to time, there is no point in waiting. The equipment available is good enough, efficient enough, for present needs; and the problem of the management is to select the proper equipment and then proceed to realize the maximum of benefit from its use.

Handling Problem in Chemical Industry

Handling, in chemical industry as in any other field, divides readily into three divisions. These are: Inbound—crudes and intermediates; interdepartmental—between processes; and outbound—finished products. The problem of the design or choice of the handling equipment is likewise concerned with three major requirements as follows:

1. To have the bulk raw materials available at the time, in the place and in the quantity desired.
2. So to move the materials from department to department, from process to process, that each piece of process equipment is kept working at its most efficient rate.
3. To remove the finished products from the productive departments in such a way that production is not blocked. To take them into and out of storage in the most economical manner. And to provide for expeditious and efficient shipping.

The Raw Material Problem

In general, all crudes should be received at one point unless the particular crude is used in only one department. In this case it may be more conveniently unloaded at that place.

The raw materials, be they crudes or intermediates, will generally be received in one of the following ways:

1. Liquids in tank cars or tank ships.

2. Bulk dry materials in cars or ships.
3. Bags in cars, motor trucks or ships.
4. Barrels in cars, motor trucks or ships.
5. Drums of solids or liquids in cars or ships.

Raw Materials in Liquid Form

The bulk raw materials received in liquid form in tank cars or tank ships may be efficiently handled in two ways—i.e., they may be pumped or they may be blown by compressed air.

In case the handling is done by pump, care must be taken that the pumps and pipe-lines are large enough to assure the desired end of unloading maximum gallonage in the minimum time.

In many branches of chemical industry the use of compressed air for blowing liquid material from tank cars or tank ships should be employed with caution, if at all, as there is some danger involved in this method with certain materials. In case this method is the suitable one to use, care should be taken to have a sufficient supply of compressed air, of a proper pressure, available when needed.

In either of the above cases, the pipe-lines used are worthy of careful study. These pipe-lines should follow the straightest course which can be obtained. They should have no traps or sharp bends. Fittings should be used as sparingly as possible. In the case of liquids which crystallize or become viscous at ordinary winter temperatures, the pipe-line should be protected from the weather and suitably heated. In any case, means should be provided for steaming out and blowing out the lines.

Bulk Dry Materials

Bulk dry materials may be received in gondolas or boxcars; in cargo ships; or, in rare cases, in motor trucks. In any case, these materials will be stored in some type of bin or in a storage pile.

Unloading will be best taken care of by dumping into a track pit from the gondolas. Trucks and boxcars should be unloaded into a pit also. For the boxcars, there are several types of efficient unloaders to be obtained, including the mechanical shovel and the portable belt unloader. This class of material is generally unloaded from a ship's hold by some type of crane, depending on such conditions as the size of the ship and the disposal of the material.

Handling this class of materials from the unloading point to storage and to process may be done by various types of handling equipment such as cranes, belt and bucket conveyors, storage battery trucks, industrial railways. The choice depends, among other things, on the amount and nature of the material to be handled and the physical conditions in the plant. Each case of this type calls for a careful study and the exercise of sound judgment in making a choice. It should always be borne in mind that the main consideration is properly to feed the process equipment—to have the right amount of material at the desired place when it is wanted.

Handling Bags, Barrels and Drums

Bags, barrels and drums should be unloaded on one central platform. This platform should be at car-floor height and can be so arranged as to serve trucks in cases where the material is so received. Where ships are used to bring this type of material to the plant, special arrangements must be made to accommodate the unloading. A scale should be placed near the unloading point so that materials can be weighed without rehandling.

This class of material can best be stored in a central storehouse. The quantities are taken from stores only as desired—a reserve can be maintained—and the feeding of the process equipment in the cheapest and most efficient manner can be more readily arranged.

Handling of materials in these containers from the car, truck or ship to the storehouse and from the storehouse to the manufacturing departments is generally best accomplished in chemical plants by some form of mobile transportation. Monorails and various types of conveyors are efficient in special cases; but small motor trucks or tractors drawing several trailers generally accomplish best the results desired.

Arrangements should be made for the economical removal of the material from the bags, barrels and drums and its movement to the start of the process in which it is used. This emptying should be done as near the place of usage as possible. Drums of liquid can be emptied conveniently by rolling them onto a track under which is a pan to be emptied by hand or a catchbasin which may be pumped out. Several drums can be emptied at once in this manner. Barrels and bags can be dumped over a grating and a drag conveyor used to get the solid material to the apparatus where it is to be used.

The Interdepartmental Problem

Material handling between departments and processes of a chemical plant depends primarily on two things: the nature of the material to be handled and the type of process equipment between which the handling is to be done. As a secondary but sometimes strongly influencing consideration there is the consideration of position, the relative elevations of the two points, the distance between them and the intervening topography.

Governing conditions will vary greatly in this phase of handling. For this reason it is possible to give only general recommendations. For handling liquids the general run of operations will be best served by gravity flow in pipe-lines where the elevation lowers and by pumping where the elevation increases. Because processes or departments of chemical plants are most often housed in separate buildings, the only general recommendation that can be made is that the solid materials should be placed in some type of container and transported by truck or tractor and trailers. There are many special cases where other types of handling equipment are the most economical; but the tractor or truck method is of almost universal application here.

The Pacemaker of Production

Most careful attention should be given to the selection and operation of the interprocess handling equipment. As stated above, this equipment must so move the material that each item of process equipment is kept working at its most efficient rate. For this reason we can call this part of the handling equipment the pacemaker of production. The output of the productive departments depends entirely upon the way in which the materials are moved through them. The workers must keep the pace of the machinery.

As a method of procedure in solving a problem in interprocess handling, there should first be determined the most rapid rate at which the process equipment can turn out the desired quality of product. The han-

dling equipment should then be chosen, designed and operated to feed the process equipment at exactly this rate. Given such conditions, it becomes the duty of management to provide the personnel to realize the best results. This problem is much simpler than the problem of obtaining efficient production where no handling system, or a poor one, exists.

The Finished Product Problem

The finished products can be classified in two different ways. First, as liquids and solids. Second, as materials to be shipped in bulk and materials to be shipped in small quantities.

The elements of the problem involved in handling these products comprise getting the material from the end of the process to the place where it is put in the container; placing it in the container; taking the container to the finished-goods storehouse; and moving the finished goods from this storehouse to the car, truck or ship in which they are to leave the plant.

Bulk Liquid Products

Bulk liquids will generally be shipped in tank cars or tank ships. The most efficient system is to move these by gravity through pipe-lines. This method is the cheapest and prevents any possibility of contamination. Where gravity cannot be used, resort should be had to pumps. The same general considerations on pipe-lines that obtain with liquid raw materials apply to liquid finished products.

It is very seldom compatible with the best efficiency to have the daily production correspond exactly with the daily shipments. For this reason tank storage should be provided for the liquid finished products. The size and location of these tanks should be carefully determined with the plant requirements and conditions fully in view.

Bulk Solid Products

Almost invariably, bulk solids should be shipped in some kind of container and not loose. The loss from waste, spoilage and contamination in loose shipments makes the container a saving rather than an expense. But this container should be the cheapest one which will give efficient service.

These bulk solids are usually in crushed or powdered form. If they are not, the case is too unusual to be considered in the scope of this paper. Some of these products are chemically active and require highly specialized containers. The general run of material of this type can, however, be handled in bags, barrels or drums. Of these three containers the bag is the best and most economical for the following reasons:

1. The cost of the bag is lowest.
2. A larger net quantity of product can be shipped per car.
3. Less space is required to store the empty containers.
4. Automatic bagging equipment is available.
5. Less labor is required for closing.
6. Bags are handled more simply than other containers.

Handling for Bulk Solid Products

If we consider only the general case of bulk solid products in crushed or powdered form to be packed in bags, an extremely simple and efficient handling routine can be established. The material can be moved from the last manufacturing process to the bag-filling equipment by a belt conveyor and automatically fed to the filling machine. The filled and closed bags from this machine should be deposited on skids and these skids taken to the storage space by lift truck.

During storage the bags should remain on the skids. In this way any rehandling is saved—for when the material is to be shipped the skidful of bags can be taken on the lift truck again and moved to the shipping point without touching the bags. One man can handle as many bags per day in this way as six could handle were a system to be used where rehandling were necessary.

In loading truck, car or ship the lift truck can run directly to the point at which it is desired to place the bags. In loading the hold of a ship, the bags have to be stacked too high for the work to be economically done by hand. About one-half the loading crew can be dispensed with if a motor-driven stacking machine is used and a very definite saving is thus effected.

Materials Shipped in Small Quantity Units

A large part of the product of chemical industry must be shipped to the consumer in small unit quantities. Although the total shipped by a plant to any given primary consumer may be large, such large quantity will consist of many small packages. The elements of the handling problem are here the same as in the case of bagged materials.

These materials will occur in various forms—liquid and solid. The difficulty of the problem lies in the fact that one plant may produce a large variety of such substances. As a result, various means of filling the containers must be employed and after filling will come the problem of handling to storage and shipping a collection of packages which often will fit no one system of conveying.

Handling for Miscellaneous Containers

It is in the solution of this difficulty that we find room for the greatest improvements. The finished materials, after leaving the manufacturing processes, can be moved to the filling department, if liquid by gravity or pump, and if solid on a belt conveyor. After the containers are filled they may be taken to storage and shipment in a variety of ways. There is conveying equipment available to solve any problem of this nature and the point is to select that equipment which will move the material most efficiently and with the fewest number of men. It is also important to keep the flow of finished product away from the manufacturing departments as steady as possible, so that there will be no tendency for the material to accumulate and clog production.

A successful solution of this problem from the experience of one of the largest plants in the country shows what can be done along these lines. The nature of their products made necessary a large variety of containers of different weights and sizes. Finding the hand method of movement too costly, they had a thorough study made of the possibilities of their case. As a result, they adopted a special type of skid having a boxlike receptacle mounted on it, the walls of which could be varied in height. They then standardized on containers—still various in size and shape—which would fit into these receptacles.

A multiplicity of these skids were built. Lift trucks handled the skids at the plant and into cars and ships.

Goods were shipped to their branches in the receptacle-skids and at those points lift trucks again did the moving. The saving effected was nine-tenths of the sum previously spent on handling.

Importance of Containers

The possibility of finding any means of successfully handling these small and varied products largely lies in the simplification and standardization of containers. There is no reasonable excuse from a manufacturing or business standpoint for the great variety of those now in use. The successful manufacturer will concentrate all his effort on supplying products packed in a few standard sizes and shapes. This will cut down the costs for storage of empty and filled containers. It will greatly reduce the time and labor necessary for filling. And it will render possible the adoption of an efficient handling system—one that will effect further savings in time and labor—one that will aid in attaining an efficient functioning of the plant as a whole.

How Good Material Handling Aids Production Efficiency

The elements of the handling problem in chemical industry and methods to be used in seeking its solution have been brought out in as much detail as is possible in a short article. Now let us consider how the solution of this problem will affect production.

It was stated above that production could be improved by bringing buildings, equipment, personnel and management to a higher level. The rôle of the handling equipment is that of the efficient servant—a servant which functions to permit its four masters to realize their best possibilities and without which they are unable to operate in harmony. Let us note some of the ways in which this servant can help its masters toward higher efficiency.

Relation of the Handling System to the Buildings

The effect of a well-designed, efficient material-handling system on the utility of the buildings is threefold:

1. It allows for a fuller utilization of the manufacturing space by doing away with the necessity for storage spaces between processes and permitting the process equipment to be placed in the most economical manner.

2. It lessens the amount of space which must be devoted to storage of raw materials, because it feeds the process more efficiently.

3. It lessens the amount of space which must be devoted to storage of finished products, because it enables the management to count on a continuous production of definite dimensions and to plan distribution accordingly.

Relation of the Handling System to the Process Equipment

The well-designed, efficient material-handling system aids the process equipment to function in the following ways, among others:

1. It feeds the material to the machine continuously at the exact rate at which the machine operates most efficiently.

2. It removes the material from the machine continuously at the exact rate at which the product is finished.

3. It prevents the accumulation of finished or unfinished goods about the machine, which reduces the space overhead chargeable to it and allows complete freedom of operation.

4. It greatly reduces the amount of labor expended on the process—both direct labor and indirect labor; allows the process equipment to function in as nearly an automatic manner as possible and thus permits the process equipment to produce its maximum at the lowest possible cost.

Relation of the Handling System to the Personnel

Some of the effects of a well-designed, efficient material-handling system on the personnel of the manufacturing plant are:

1. It reduces the personnel to the lowest possible number.

2. It permits the employment of only the skilled or semi-skilled class of workers.

3. It enables the employee—provided the other elements of building, process equipment and management are efficient—to work at his best and hence command a high rate of pay.

4. It takes the burden of physical labor from the laborer and makes him a brain worker.

5. Through the four gains stated above, it helps to achieve the maximum of production per dollar of payroll and hence increases the production efficiency.

Relation of the Handling System to the Management

Good material handling is the mechanical substitute for management:

1. By relieving management of a vast burden of detail, it permits management to function in a broader way, to maintain a better control of the elements of production and more successfully to anticipate fluctuations in productive demand.

2. We have called mechanical handling the pacemaker of production. It gives the management much more dependable production figures than could be had with manual methods. It holds the worker—easily and without overstrain—to a definite and high productive pace—and this with little effort along the lines of supervision.

3. Clerical, administration, insurance and other overhead costs are greatly reduced. This follows naturally on the lessening of the labor force and the greater ease of obtaining cost figures and other data which management needs.

Relation of Material Handling to Productive Efficiency of Manufacture

Material handling knits manufacture into one whole and permits management to treat it more and more as a unit, as a machine, to which material is fed and from which finished goods are received. This trend, carried to its ideal end of perfectly effective manufacturing elements—buildings, process equipment and personnel—co-ordinated in effort by a perfectly adapted automatic handling system, would result in the practical elimination of all management and the realization of the minimum production costs. This is the goal—one which can never be reached, but toward which the mechanical handling system is rapidly carrying those who are far-sighted enough to take advantage of its possibilities.

Frankford, Pa.

Wages

The Fundamental Relations Between Employer and Employee Upon Which Wage Payments Are Based—Essentials of a Good Wage System—How Wages Should Be Measured—How These Theories Work Out in Practice Illustrated by the Results Obtained in the Ford Industries

BY HARRINGTON EMERSON
President, The Emerson Engineers

I WAS brought up on the Bible, my father being a clergyman, and I still turn to it for instruction. What I like about the Bible is that it gives us principles rather than expedients.

As I read the texts, these principles seem to be, that the relation of employer and employee is very exalted, comparabie to the Kingdom of Heaven; that wages rest on free contract and agreement; that standard wages are by the day and payable daily; that the factory is the employer's own and he has the sole right to judge of his needs; that he can freely select those who are better than others and that he can pay these better men a higher wage, but not pay a lesser wage than the standard to any employee, however incompetent, and that wages shall not be oppressively low.

Fundamental Relations

"For the Kingdom of Heaven is like unto a householder which went out early in the morning to hire laborers into *his* vineyard, and when he had agreed with the laborers for so much a day [not by the hour or piece] he sent them into *his* vineyard." And he hired other laborers later and said unto them: "Go also into the vineyard and whatsoever is right, that shall ye receive."

And at the day's end he paid none less than he had agreed and that they had voluntarily accepted; and he paid some more than they expected, and some expected more than they had agreed for and they murmured; but the householder answered one of them and said, "Friend, I do thee no wrong. Didst thou not agree with me? Take what is thine and go thy way. Is it not lawful for me to do what I will with my own? The last shall be first and the first last, for many are called but few are chosen."

The Bible is very severe against delays or holding back of wages or arbitrary reductions.

"The wages of him that is hired shall not abide with thee all night until the morning."

"Behold the hire of the laborers who have reaped down your fields, which is of you kept back by fraud, crieth."

"I shall be a swift witness against those that oppress the hireling in his wages."

"Your father hath deceived me and changed my wages ten times."

And this for the wage earner: "Do violence to no man, neither accuse any falsely, and be content with your wages."

I knew a modern enterprise with three thousand employees that paid them all off daily.

Evolution of Employer-Employee Relations

A further fundamental fact about the relations of employer and employee is that the evolution is from status to contract. There was a time when workers were slaves, working like horses, without wages; but for food, shelter and clothes. Then came serfs, part of whose time was their own, but they could not leave the land; then came the "corvée," forced labor without compensation. The worker had to do the master's work first. We are slowly, oh, so slowly, progressing into full contract; but many harmful restrictions still linger on. Man is an animal, very slow to observe and adopt improvements. Five hundred thousand years ago he observed insects and birds flying all about him, but until this generation it never entered his head to try even to glide. So also in the matter of wages, we have not nearly reached full contract.

Because conditions have improved in the last hundred years and because labor unions have agitated for better conditions, for the abolition of abuses, it is, without reliable foundation, claimed by some that trade unions deserve the credit for the changes; and that without trade unions there would have been no progress. This is an untenable conclusion.

Development of Contract Relations

In earlier centuries the Church inveighed against the practice of keeping Christians in bondage and practiced manumission.

The anti-slavery agitation of the last century was due to the advancing spirit of humanity preached by the reformers of the eighteenth century in France, which worked out into the French Revolution, with its slogan of "Liberty, Equality, Fraternity."

In England a form of slavery existed down to the end of the eighteenth century. Colliers and salters, on entering into a coal work or salt mine, were bound by the law, independent of bargain or agreement, to perpetual service; and in case of sale of the ground, their services passed with the title. The sons of the collier and of the salter could follow no occupation but that of their father and were not at liberty to seek employment elsewhere than in the mines to which their fathers belonged.

It was decided in 1772 that no slaves could be imported into England. In 1787 a society was formed in London to suppress the slave trade. Wilberforce and Pitt agitated in Parliament. Slave trading was made illegal after Jan. 1, 1808, and in 1811 it was made a felony; in 1824 it was made piracy. The French freed their negroes in 1848, the Dutch in 1863. In the United States slavery was curtailed, not through the efforts of the slaves or of labor unions, but through the opinions of enlightened individuals as Franklin, Washington, Hamilton, Jefferson. The Pennsylvania Abolition Society was formed in 1775. William Lloyd Garrison, Wendell Phillips, Arthur Tappan were active in 1831. The Free Soil party was formed in 1848. Slavery was ultimately abolished in the United States, Jan. 1, 1863.

The modern theory of work is that the better the worker the lower the labor cost. The modern theory is

that the worker is a supervisor, but tools and machines do the heavy work. These theories have been enunciated and put into effect by enlightened and progressive employers in advance of and beyond any claims of trade unions. The Cadburys in England, also Lord Leverhulme; in the United States, above all others, Henry Ford and the American Rolling Mill Co. have led the way.

Essentials of a Wage System

It is easy to enumerate the essentials of a good wage system.

(1) Free agreement between employer and employee as to the basic daily wage for the locality and occupation.

(2) Definite understanding as to the amount of output, whether through direct work or supervision, or both, that is to be given as an equivalent of the wages. (This is often wholly ignored by both parties to the contract. It is exceedingly rare to find any agreed to equivalents, much less fair equivalents.)

(3) An understanding that any deviation by the employee in the way of delivering more than the contract wage equivalent shall be fully recognized and paid for by the employer.

These essentials are embodied in the wage agreements with trainmen.

The wage is so much per day of 8 hours. An agreed-to number of miles is a day's work. More miles within 8 hours, or more than 8 hours, receive extra compensation.

An Additional Principle

A fourth principle is looming up—namely, that the shorter the day the higher should be the pay per hour; the longer the day the lower the pay per hour. This principle is based on the fact that a supervisory or manual or mental worker can deliver more per unit of time for a few hours than during many hours. A sprinter can run 100 yards at the rate of 20 miles an hour, but for 2 hours the rate of speed drops to 10 miles an hour. A man can fight but a few prizefights in his lifetime; he can do less strenuous work continuously for 60 years.

The time is coming when the shift will be 4 hours or 6 hours and the man who takes six shifts a week, one a day, will receive more per hour or for the shift than the man who takes more than one shift a day.

Principles are eternal, expedients are excellent within the limits of principles. Even if I advocate expedients, I go back into antiquity for principles.

What Wealth Is

An error we must banish from our minds is that work creates wealth. Work creates production, but if consumption equals production, there is no wealth. Wealth is the difference between production and consumption and is an individual matter. Many of us produce, but we are not wealth creators if we consume more than we produce. The man who produces, or earns, $1 a day and consumes $0.90 is not only a producer, he is also a wealth creator.

The man who earns or produces $50 a day and spends, or destroys, $60 is a wealth destroyer. He is like a weed in a cornfield. He utilizes his power and the gifts of nature to no purpose.

Those who are producers but also spenders often imagine that they have created existing wealth. Only in so far as they saved did they create any wealth. Two men work on a house. Their labor produces it. Each receives $4 a day. One spends it all. He smokes, he chews gum, he goes to the movies, he rides on the merry-go-round, he is a devil of a fellow (it is assumed that he does not drink). The other saves a dollar a day and at the end of 10 years owns the house both built. A revolution comes. The spendthrift soviet, the communist, points to the house and says, "Behold what my labor created! Down with the bourgeoisie!" Yes, his labor created it, he was paid for his labor and he spent the proceeds as he chose.

It is a fundamental error to imagine that because I am poor someone else has grabbed off my share. If I do not breathe deeply, it is my own fault, for the oxygen is there. If I stick in a tenement cellar, the fault is mine, no one else's. I remember two cases which taught me much.

Examples of the Above Principle

Many years ago there was an immigrant garment sewer, with a large family. He lived in a New York cellar. When the spring came, he bought a tent and some cots and moved out onto the Long Island shore with his and his wife's sewing machines. Milk and vegetables were to be had from the neighboring farms, some chickens were obtained, the children weeded gardens and did other chores, they fished in the sea, they reveled in the salt water and sunlight; while he and his wife stitched. The finished garments went into the city by express, the unfinished ones came out the same way. At the end of the season his boys and girls were brown and lusty and strong, self-reliant, fed up on vitamines. Few millionaires could, or would, have done as much for their children!

The other story is of the survey of the conditions of a New England factory village, by a physician. He ascertained twelve causes for poverty, disease, misery.

The mill was responsible for a measure of bad health, because there was dust in the air, a preventable evil which it should have been compelled to remedy.

The eleven other causes were:

Bad food,	Narcotics.
Badly cooked,	Bad clothing.
Badly eaten.	Irregular habits.
Bad, unventilated living and sleeping quarters.	Personal uncleanliness.
	Sicknesses.
Drink.	Contagious infections.

This mill and its workers were wealth producers, but not wealth creators. Character had not kept pace with individual production. It is not the system that is at fault, it is the individual.

Further Examples of Wealth Production

Only a few days ago I heard of a young man who worked his way through college, who is only 35 now, who works from 8 a.m. until midnight, who has earned and saved a million dollars.

I have also watched with interest a small isolated group of foreigners in our great New York. A Jewish landlord who speaks a mangled German and an amusing English owns two houses, which he has rebuilt into room and apartment houses and rents furnished. He has obtained two Austrian families, each with male relatives. The hard working, thrifty Austrian women act as caretakers, giving maid service, the men work at their trades, and at night and on holidays and Sundays they work overtime remodeling houses. All send astonishingly generous contributions to dependent rela-

tives in stricken Austria, the young men budget their incomes and save; one of them has over a thousand dollars saved up. They are not "reds" or destroyers, they are upbuilders, wealth creators and they think the United States is a land of glorious opportunity.

Fundamentals of Wage Rate Establishment

Avoiding those two fundamental delusions of the twentieth century, that there is not enough to go around and that the unsuccessful have been deprived of opportunity, we can enumerate the few fundamentals.

The Measure of Wage

The current wage is to be measured by a time unit, as the day, the week, the month, the year. The wage earner has daily expenses for eating and sleeping, like the rates at a hotel, he has monthly expenses for bills and for rent, he has yearly expenses for clothing, for insurance, for education, for holidays, etc. As a matter of expediency in accounting, it is desirable to figure wages on an hourly basis, but the amount earned by the day or the week or the month or the year should not be lost sight of. Expenses are not by the hour, which is merely a convenient accounting unit of time.

Wage Rates Competitive

The wage rate should be the current one for similar work and skill, at the time and place. This rate is a competitive one and cannot be based on any sentimentality as living wage. We might as well understand that there are certain matters beyond human power to regulate. The sun shines and we have floods or droughts, hail falls, varying the return from the soil. We starve or we have plenty, the sun pays no attention to our living needs. We could take lessons from the frogs, biologically older than we are. When food is plenty the tadpoles to a larger extent turn into females. The race is broadened. When food is scarce, the larger number of tadpoles become male frogs, the quality of the race is improved.

The current wage, whether by the hour, day, week, month or year, should be arrived at by mutual agreement and bargaining and the agreement should be adhered to by both parties.

As an employer, I would always make the basic wage higher than the current rate in the district, not from any spirit of philanthropy but because of another great principle.

Quality, up to a certain point, increases faster than cost. This is true both as to industrial materials and as to industrial service.

High-speed steel in machine shops is worth easily a thousand times as much as carbon tool steel, but it costs only four times as much. A good leather belt costs perhaps twice as much as a poor leather belt, but will last ten to a hundred times as long and will lose 5 per cent less power, and interrupt work less often, by breaking. In Mexico I found a case where failure to obtain a good main drive belt had shut down a whole section of a machine shop for a year.

Poor medicines of insufficient strength kill thousands.

It is not the fanned almonds or peanuts I want, at their reduced prices, nor the cull fruit, nor the shoddy cloth, nor vinegar shoes and paper stockings. When I was a boy my socks were knit by hand out of handspun and hand-woven flax, sun bleached, snow water rotted. These socks wore like iron without a hole for years and years, but they cost less than I now pay for flimsy stuff.

Similarly with service work. It is not the lowest priced servant or clerk or worker of any kind who is valuable.

As an employer, I want to pay the highest, not the lowest, wages in the district. I want to pay more than the worker has individually earned.

Relation Between Wage and Service

For all wages paid there should be a definitely predetermined relation between payment and service.

It is astonishing that this fundamental requirement is still so universally ignored. In spite of decades, almost centuries, of experience, we have not yet got away from status. The horse is ours, feed him we must, as little and as cheaply as will keep him alive and in strength, and then get all the work possible out of him! This is status. Contract is something quite different. There is a definite payment per hour or per day for a definite service per hour or per day.

A good example of equivalent for wages is furnished by Henry Ford's moving assembly track. It moves at a definite rate, in an 8-hour day so many cars are assembled, the worker has skill commanding $6 per day. He must be skilled enough to acomplish what he has to do on each car, on each side of the car, in so many minutes. Henry Ford, better than any other great industrial, knows exactly what his manufacturing costs are per hour and per piece. The man cannot work faster or slower.

The fireman on an express train locomotive takes so many hours to a run and shovels on the average so many tons of coal. If the coal furnished becomes of much poorer average quality, if more cars are permanently added to the train he is entitled to a readjustment.

The living wage is sentimental absurdity. The state may prohibit me from working more than 8 hours a day and prohibit my earning less than 50 cents an hour when I work, but it cannot guarantee me 8 hours. Ten, 20, 30, 40, 50 up to 90 per cent or even more of us may be idle. Those who work receive the living wage, those who are idle starve! What they do in reality is to live off of those who are working or who did work.

The Basic Wage

This brings us to the fourth great fundamental. There is a basic wage for the trade in the district at the time. More workers will get it in flush times; good workers will get it in slack times.

Every worker is entitled to additional emoluments or to rebates for any deviation from the current standards.

The best illustration of the whole principle is found in walking. We have three elements, the walker, the weather, the condition of the road.

It is on the combination of these three that the normal performance will depend.

Normal Performance

What is normal performance? What is normal performance for heart beats, or for breathing? It is not the sudden and brief palpitation of extreme excitement, not the rapid breathing of extreme exertion. Yet also it is not the 2 minutes during which one can hold one's breath nor the rare occasion when the heart slows down or even stops. Normal performance includes both extremes. It is the total minutes of life divided into the total heart beats or the total breathings. A normal performance is therefore set up for a year at least, or

for longer, and this is wholly incompatible with any 8- or 10- or 12- or 6- or 4-hour day. We may attempt the 8-hour day, but if we adopt it as the maximum, we shall have many days of less hours and in the year average only 6 or 5 hours.

Eight hours, 6 hours, 4 hours is an industrial dream. A man should work as long as he likes to and is not overfatigued. Europe is repudiating the 8-hour day. France knows and Germany knows that working 8 hours a day Germany cannot pay the reparations and that working 10 hours she could.

This is what Keil, Minister of Labor in Württemberg, states: "If Germany is to recover from her war losses, pay her reparations and free her territory she must work 2 or 3 hours a day longer." Professor Lindemann of Cologne states:

"Germany must either lengthen her hours of work to pre-war length or she must suffer chronic hunger and suffer a rapid deterioration in national welfare and health."

Co-operation a Necessity

Chess is a very fine game. Two opponents, equally matched, sit opposite each other and each tries to do the other, to weaken him, to put him in a hole from which he cannot escape. The relations of employer and of employee have for centuries been of the chessboard type. This is unfortunate. Both cannot win. It is seldom that a game is drawn; there is generally a loser. This is not the relation between different parts of the body. The two hands, the two eyes work together. In playing a violin which hand is more important? Every part of the human body works in harmony with the other part. Employee and employer are in the same boat and neither should rock, each should pull equally, on his own oar.

How These Theories Work Out in Practice

In all the centuries there came one man who instinctively got the right idea and he has probably had less labor troubles per thousand employees than any other employer on so large a scale who ever lived. I can at least imagine his theories, which are so sane that at the start they seemed crazy.

Suppose, then, we set forth these theories in the form of a Socratic dialogue, by which method they will be made most clear to the understanding.

"Here is a new form of transportation, a self-propelling vehicle. There are 100,000,000 persons in the United States. At least 15,000,000 of them would like to have a buzz-buggy."

"Why, Mr. Ford, the farmers begrudge paying $75 for a horse buggy; the farmers did not even buy bicycles."

"It makes no difference; 15,000,000 would like to own a buzz-buggy."

"But there are no roads. That is the reason there were few bicycles far from city streets and park drives."

"It makes no difference, roads will come."

"But there is very little gasoline, not enough for 1,000,000 automobiles."

"That also makes no difference. Gasoline will come."

"But these buzz-buggies, good ones, cost $8,000 each and it takes quite a good farm to be worth $8,000."

"I expect to bring buzz-buggies down to the price of a team of horses."

"How are you going to do it?"

"There are only three elements of cost: equipment or investment costs, personal compensation costs, and cost of materials. In an automobile, whether it costs $8,000 or $300, the three elements are there and in substantially the same proportions."

"What is it going to cost to supply an automobile?"

"It will cost me exactly what 5,000,000 persons are willing to pay. If, when automobiles are selling for $2,000 a man wants to pay me $1,000, I shall furnish it, and if, when others are selling for $1,000, I find the crowd is willing to pay $800, I will built it at that price, and, if the crowd is willing to pay $600, $500, $350, I shall furnish it, still observing the proportions of perpetuation of investment costs, personal compensation costs and material costs."

"Do you mean to say that you can reduce the investment charge to one-third?"

"Yes, by working my equipment continuously. If the same machine makes each 24 hours three times as many gasoline tanks, the investment charge drops to one-third."

"But how about wages? A man cannot work 24 hours a day, like a machine, and turn out three times as much."

Man as the Machine Supervisor

"No, but the modern idea is that man is a supervisor of equipment, a handler of materials, not a muscular drudge like a mule. There is no limit to the amount of equipment a man can supervise, nor to the amount of material the supervised equipment will handle. Therefore, to reduce the man cost to any extent desired, all that is necessary is to obtain more intelligent men than the average and I obtain such men by paying them more."

"But what about materials? A car's weight has not dropped to one-third."

"The actual first cost of steel and of rubber and of wood is very small, the scrap value of a car is at most 2 to 3 cents a pound. All the rest is equipment and personal compensation cost, and by enormous production these can be brought down.

"What is the method?"

"It is very simple. We find that we can sell cars by the million if they cost only $300 each. Let us assume that the three costs are, for perpetuation, $75; for personal compensation, $75; for materials, $150. Can a $6 a day man do all the work on a car in 12 days? He must! We can give him the machines to do it!"

What Will Follow the General Adoption of These Theories

The possibilities in this line are beyond belief. I have seen a material and man cost of $6 reduced to 6 cents, a labor cost of $25 reduced to 5 cents. I have seen a wise investment of $100 in equipment reduce man cost more than $100,000.

The wage question is, therefore, not whether the employer can do the employee, nor the employee do the employer, nor yet whether both can extort high prices for small quantities from the purchaser; but whether a fair ratio can be established between perpetuation costs of equipment, personal compensation costs and machine costs.

If the relation is established and if all three combine, the result is vast quantity at low price to the public, opportunity to invest largely at low rates, high compensation to skilled men for short hours.

New York City.

Measuring Administrative Efficiency

The Problem of Administration Today — Fundamental Questions of Administration—The Questions Can Be Daily Answered by the Intelligent Use of the Proper Control Charts—The Time Concept of Administration Is the True Basis of Control

By Walter N. Polakov
Of Walter N. Polakov & Co., Inc., Engineering Counselors

The post-war industrial situation has shifted the administrative center of gravity from making workmen personally efficient to making administrative organization flexible enough to meet the rapidly changing situation.

We have developed a high state of technique, especially in chemical and metallurgical industry, because of a broad application of engineering research. Theoretically and practically competent chemists and engineers are available; workmen, seeking steady employment rather than high wages, readily develop necessary skill under competent training; but administrative leadership meets with new difficulties.

Problem Before Industrial Administrator

To analyze a situation, first of all intelligent questions must be asked; then these should be answered. Men of average intelligence seldom know how to formulate a question; men of higher intelligence can ask clear and definite questions; but only trained men in each profession can both put a question and give an answer to it.

The problem before an industrial administrator of today is not only that of formulating pertinent questions in order to bring forth the nature of the rapid changes in industry; not only to answer these questions, thus pointing out the relation between cause and effect; but, essentially, to act according to the facts disclosed and thus get things done.

Place of the Industrial Consultant

It might be well to leave the analysis of the situation and the interrelation of changing causes and effects to the care of trained and experienced industrial diagnosticians, who, by virtue of their profession, have a horizon broader than any one plant or any one industry; who, thanks to years of experience in various fields of industry, have acquired the technique of putting questions and evolving answers; who, for this purpose, have devised a method of informing the administrators with the least loss of time and energy and with the utmost accuracy and precision what to do and when to do it, leaving the question of how to do it to the technical staff of the organization.

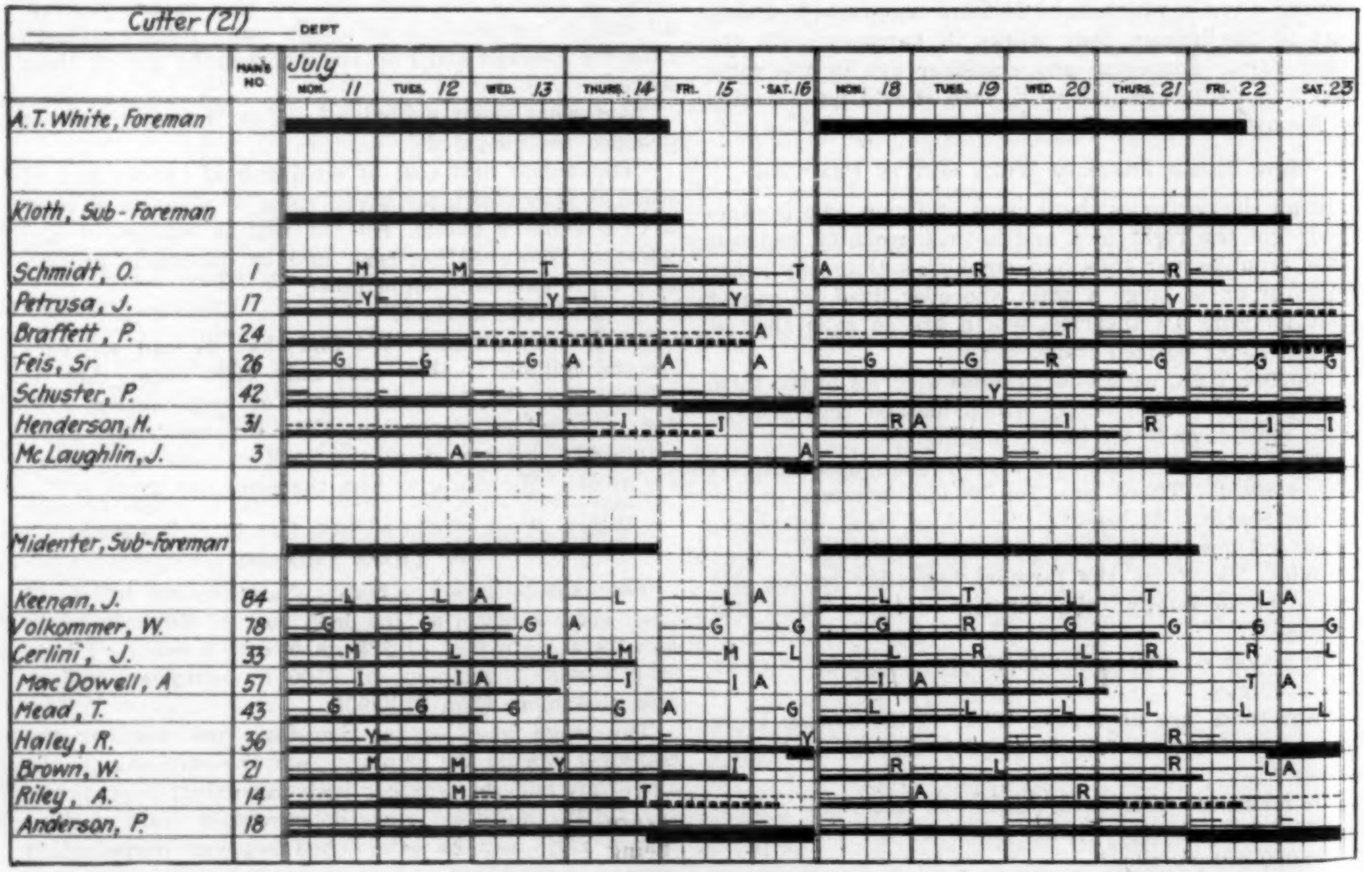


FIG. 1—MAN RECORD CHART.

Each daily space represents the amount of work to be done in a day. If less was made, the thin line is drawn proportionately shorter; if more, the lines are doubled up at the end. Broken lines indicate time taken for jobs about which it was not known how long they should take. Heavy lines are the summaries of the work done per week. Thus one of the subforemen got out more than 4 days' work in a week while another just 4. The next week the first subforeman got out more than 5 days' work in a week while the second was still a day behind. Letters after short bars denoting less work done in time allotted indicate cause of delay thus: *A*—absence of operator; *G*—green operator; *T*—tool trouble; *I*—instructions missing; *M*—material causing trouble, etc. When the trouble is so known, it enables those responsible to find a means of eliminating it.

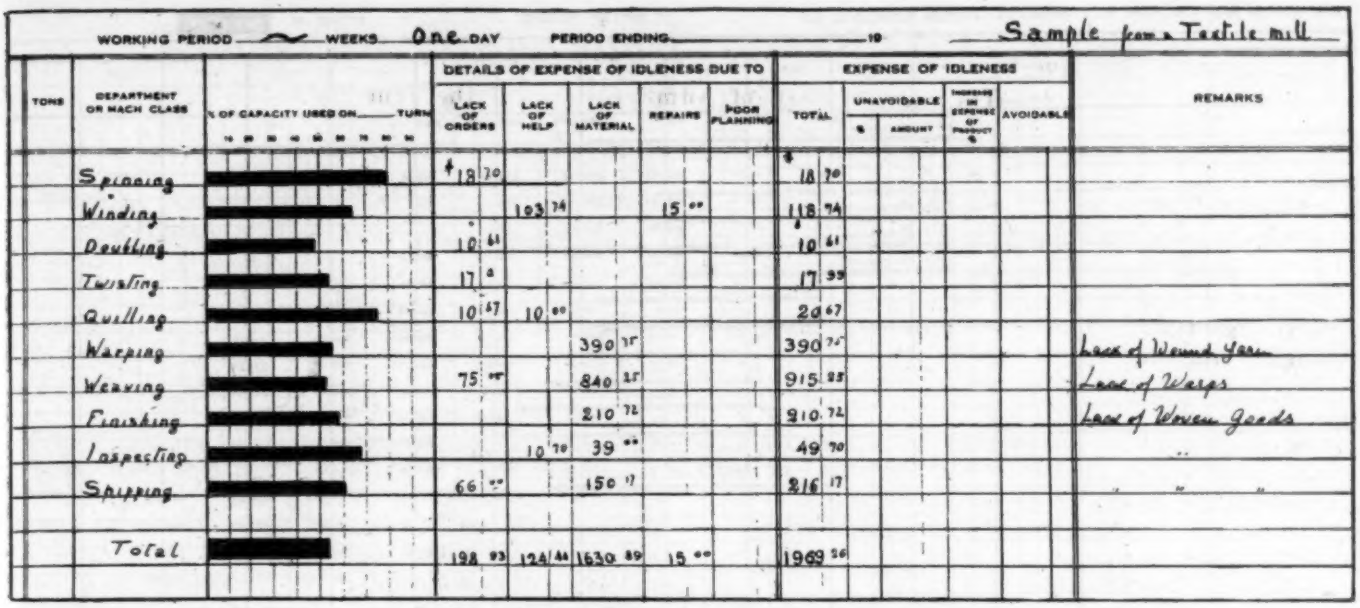


FIG. 2—MACHINE RECORD CHART

The idleness of productive capacity indicated by this Gantt chart is also interpreted in terms of expense involved. Mill that had on hand enough work to keep 80 per cent capacity busy (spinning) produced only 55 per cent of total output, having large portion of the equipment idle for various classified reasons. Note how delay in hiring winders reflected in heavy losses in warping, shortage of warps caused idleness in weave shed, etc., down the line. Such knowledge readily directs the efforts of executives toward the trouble at its origin and enables them, through knowledge of the cause, to find the remedy.

Fundamental Questions for Administrators

The fundamental questions that must be asked and answered in any industry, in any establishment, are:

1. Is the most needed work done first and will it be completed in time? If not, why not?

2. Is the plant equipment utilized to the fullest extent? If not, why not?

3. Is the available knowledge and skill applied in the fullest measure? If not, why not?

There might be an endless number of other questions asked; but the answers to all must be deferred until the replies to these three cardinal questions are daily received and use is made of these answers.

Figs. 1, 2 and 3 suggest the graphic method of getting the necessary facts for answering the three questions just mentioned.

A more specific instance taken from files of one of our clients shows by chart how the record of fuel utilization in a power plant reflects not only a better utilization of available knowledge and skill, but simultaneously provides management with an accurate means of measuring the quality of work and provides men with stimulating scores of their game against bogey—a standard of perfection toward which they are making marked progress.

Proper Measurement the Basis of Administrative Control

The practical task of controlling production must of necessity begin with measurement; and, to be correct, measurements must be made in the proper dimension. It would be a grave blunder to apply a unit of one dimension to an entirely different dimension, or to use a measurement which contains a variable element. We cannot use for measuring human work the units of mechanical power such as foot-pounds or horsepower, which would embrace only the muscular work of men, even though these expressions contain the time rate, for it would be a confusion of a part with the whole. This time rate of man's work is the only measure of production which is of the same dimensionality as the energy causing it and it is as constant as the solar system itself.

Since time may be spent for different purposes and the amounts of work that can be done in a unit of time may differ of necessity, the scales may be as varied as are human activities themselves; but we cannot conceive human activity without or beyond time.

Charts Which Answer the Questions of the Administrator

Time, in its relation to our existence, is divided into present, past and future. Hence we have three fundamental managerial problems visualized in three forms of charts: applied to the present or to current work, the Man Record Charts; referring to work done in the past, the Machine Record Charts; and projected to future work, Progress Charts, with their schedules laid out on the time scale of future requirements.

The Man Record Chart

During the time devoted to productive work there is a variable amount of work done, and this is what is shown on the man record chart, but this work is performed and directed by men. "To feel the lure of perfection," says Prof. C. J. Keyser, "in one or more types of excellence, however lowly, is to be human; not to feel it is to be subhuman." And a chart of this kind involves that ideal of service. It shows what is expected to be accomplished within the work time for any occupation, however lowly.

In such a chart this ever-striving impulse of self-expression in service which throbs in every human being is given adequate expression and stimulus. It is accomplished by predetermining the ideal, however modest, which is accepted by a man as within his power of attainment. Then, and only then, can the lines of attainment be drawn from day to day to denote falling short of the aim, or equaling, or surpassing it, as the obstacles of inertia, ignorance or lack of co-ordination are overcome by the strongest of all human propensities

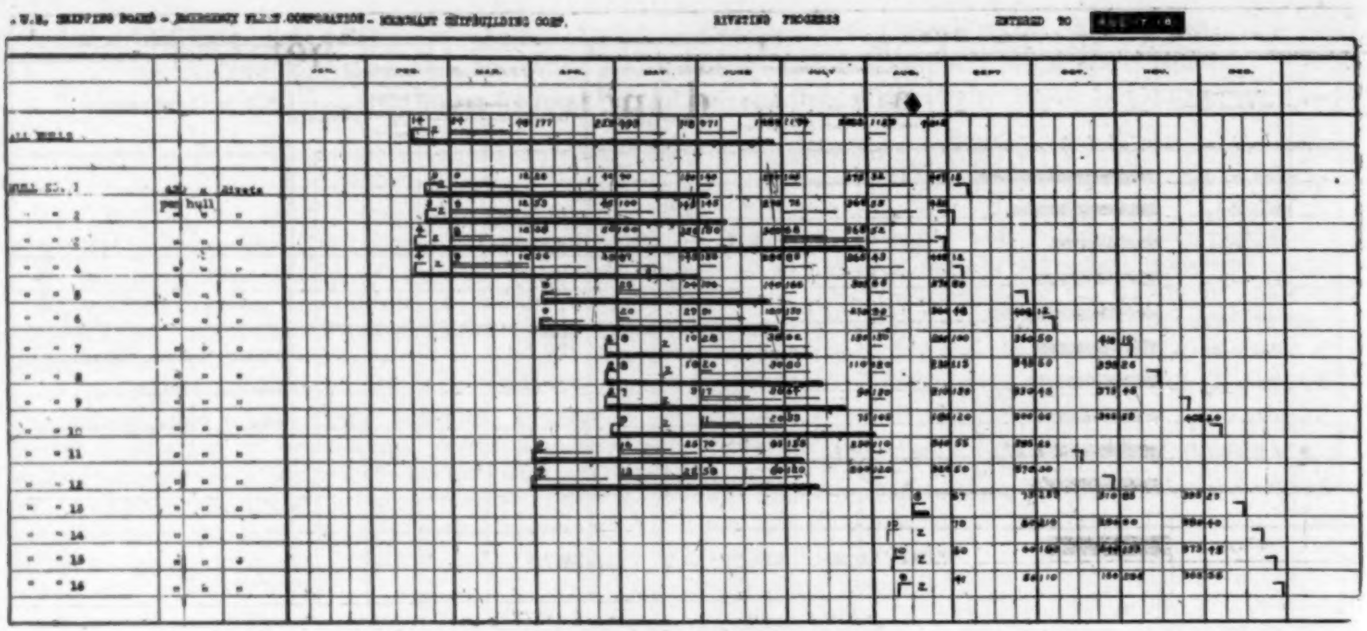


FIG. 3—PROGRESS CHART

Each hull of the sixteen boats under construction was scheduled for completion at the time marked by a half bracket ⌉. In the middle of August (when this chart was entered) the work was about 7 weeks behind the promise. Amount of work done on each hull during each month is shown by thin lines and cummulative total by heavy lines. Numbers on the left of each monthly space show the number of rivets that are scheduled for that month, and on the right the number to be completed by the end of the period. For instance, the record of the hull No. 3 indicates that in May only 50,000 rivets were driven instead of required 100,000, while in July two and a half times more was done than scheduled in order to catch up, or 170,000 rivets instead of 68,000. Same principle and method are equally applicable to any factory, department, contract or activity.

—the desire to excel oneself. This type of chart can truthfully be called a tool for humanizing industry, for it not only reveals to a man his own dignity and capacity as a creator, but subtly, though persistently, calls for co-operation between brain and brawn in accomplishing the work. It tells what each and all are doing at present.

The Machine Record Chart

The machine record chart reveals to one who reads between the lines much more than merely the time a certain machine was idle. Its scale is also time; but the time during which a machine remains unproductive has a graver significance than a reminder that "time is money." It means that someone, who should have operated it or supervised its operation, did no work; and the time of inventing, developing and building this machine, which is greater in its productive significance than the time of the operator, is irretrievably lost.

The Material Utilization Chart

The material utilization chart—like the charts already shown — indicating the waste of material or energy, also has a deeper meaning. It shows the extent to which the work of other men in recovering, preparing and delivering this material or energy has been destroyed. It means that the work of hosts of other men has been rendered useless and their productive time forever lost. This type of chart gives us the measure of our utilization of work that has been done before. It proves whether we are worthy of our inheritance from the past.

The Progress Chart

The progress chart integrates all elements of work; it sums up the progress made, its acceleration, its retardation, its time rate. Like other charts, it brings together the ideal and the fact. Its ideal projects into the future and sets before us the task which we are called to perform—no matter how small or how great it may be—whether filling an order in a shop, feeding a nation, or advancing the life and happiness of mankind. It calls for a plan and vision of the future. It is based on knowledge of the past and it reveals our position at present.

This Time Concept Is the Basis of Efficient Administration

The time concept in the control of industry, direction of production and measurement of human work thus stands revealed as the wished for solution, free from errors of confused types and dimensions. It refers all facts to the irreducible and final element of human life—time. Because it is true to the human dimension, it is both human and humane; hence it obliterates conflicts between men and management, promotes the fullest exercise of man's creative forces and places work in its proper relation to life.

Such and similar work of engineering administration and industrial counselor prompted our great American mathematician—Prof. C. J. Keyser—to define engineering as: "The science and art of directing the time-binding energies of mankind—the civilizing energies of the world—to the advancement of the welfare of man."

This definition itself is but an apt formulation of the admirable time-binding work done by some of our leaders and an excellent example of the far-reaching implications of Korzybski's concept of man as the time-binding class of life. It is indeed, highly significant that Calvin Rice, secretary of the American Society of Mechanical Engineers, in a recent message called the attention of the engineering profession to this function and responsibility.

To measure the time-binding quality of industrial administration is today beyond any doubt a task before which any other transient problem shrinks into insignificance.

New York City.

Steam for Power and Process in the Chemical and Allied Industries

General Considerations in the Use of Steam—Control System Should Be Simple and Thorough—Establishing This Control System Through the Work of a Test Engineer—Functions of the Test Engineer in Boiler Room, Engine Room, Distribution System and Process Work

BY HERBERT B. REYNOLDS
Mechanical Engineer

WITH the increasing cost of coal and other fuel, more and more attention is being given to its economic use. Even in the large power stations, where there has always been more or less stress put on the efficient use of coal, the managements are constantly on the lookout for means of reducing the consumption of coal. However, it is in the smaller industrial plants that the greatest opportunity lies for conserving fuel.

It has been the author's experience that even in some of the best-managed establishments, where the most modern methods are applied in the manufacturing end, wastes have been permitted to go on in the boiler and engine rooms without receiving notice. As long as the voltage is on the line and the steam and compressed air pressures do not fall too low, there is no complaint. However, in the meantime it may be costing twice what it should cost to maintain the service.

THE REASONS FOR INEFFICIENT METHODS

This general inefficiency in the industrial plants is often due to the fact that those responsible for the management of the factory are specialists in the manufacture of their particular product and have no interest in the power end, which is in most cases quite foreign in nature to the manufacturing end.

I have known cases where a piece of equipment has been purchased for the manufacturing end of an establishment, the use of which may give a moderate return on the investment; while, on the other hand, the veto has been put on the purchase of some inexpensive equipment for the power house which should pay for itself many times within a year. The reason for this, as above mentioned, is that the management knows nothing about the power end; and, furthermore, it does not want to know anything. Often the only thing known about the power plant is that it is a necessary evil, and can cause a lot of trouble if it has to shut down for any reason or other.

POWER COSTS SHOULD BE DETERMINED

All modern manufacturing plants maintain a very extensive and detailed cost system, from the records of which the cost on each particular manufacturing operation or process can be obtained with the highest degree of accuracy. If the cost of any particular operation or process takes a sudden jump, a lot of explaining has to be done. In addition to this, a corps of experts is employed to make time studies, motion studies, etc., in an endeavor to reduce costs. However, a great many of those well-managed plants do not know how much a pound of steam or a kilowatt-hour of energy costs them, although these costs may form no small part of the total manufacturing costs. The power station costs in these cases are generally thrown in with the overhead, where it is difficult to detect any variations due to inefficiency in the use of fuel.

FUNDAMENTAL COSTS IN STEAM PRODUCTION

Where records are lacking, the means for determining these records are generally lacking. Most plants know how much coal they use during a period, say a month; but a great many have no means for determining the output of their power department. Without knowing the output of both electric and steam power, no check can be kept on the operation of the plant. In order to obtain the output no very elaborate equipment is required in most cases. It is difficult to make any general recommendations as to what records should be obtained, as the class of service in various plants varies so much.

There are, however, two items which should be obtained in every plant. They are the amount of coal burned and the amount of water evaporated into steam. By knowing these two items, the efficiency of the boiler room operation can be determined. It may be well to state right here that this item is one of the most important for the management to watch, as there is no other place in the plant where more loss can occur due to indifferent labor. The determination of the engine room efficiency is a more difficult matter, especially in those plants which render various kinds of service such as electric power, compressed air, high- and low-pressure steam, refrigeration, etc. However, an endeavor should be made to obtain such records by means of which a check of the engine room performance can be had.

REPORTS ON STEAM GENERATION

As to just what records the management should have submitted daily, weekly or monthly, this is also difficult to outline so that it would be applicable to all plants. However, this report should be very brief and contain only those items which are of direct interest to the management, such as total coal consumed, water evaporated per pound of coal (boiler efficiency), total kilowatt-hours of electric power generated, etc. It is often desirable to submit this report in graphic form so that any change in the performance of the plant will stand out and be easily detected.

CONTROL BY MEANS OF A TEST ENGINEER

In order to inaugurate a system as outlined above, a young technical graduate should be employed. This position should be filled with great care. A man who has had several years' experience in the efficiency department of some large central station should be obtained.

He should possess tact and initiative; and should have a pleasing personality which will enable him to gain the confidence and good will of the operating men in the boiler room and engine room. The title of this man should also be selected with care. Titles such as efficiency engineer, betterment engineer, etc., should be avoided, as titles of this nature are apt to prejudice the operating men against him. The title of test engineer will be satisfactory in most cases. The test engineer should report to the man who has general charge of the power department.

It should be impressed upon the test engineer that everything he does should have either a direct or an indirect bearing on the improvement of economy. Otherwise there may be a tendency for him to make the place look like a Christmas tree by installing all kinds of instruments, and to fill the files with high-brow technical reports containing the results of elaborate tests. On the other hand, it will be necessary for him to run certain tests and collect data which will be of no interest to the management and which may appear to be useless.

Isolated Plant or Central Station

There is one question which manufacturers who use more or less electric power generally ask themselves, and that is whether or not they could save money by purchasing their power from the nearest central station. This question cannot be answered until each case has received very careful engineering study. In general, if the power consumption is large compared with the demand for low-pressure steam for heating or process work, then it may pay to purchase power. However, in most chemical industries, with the exception of those employing electrolytic processes, the demand for power is small compared with the steam load. In these cases it is doubtful if any saving can be accomplished by purchasing power, especially if the private plant is fairly well managed. However, as stated above, this question can be answered only after a very careful study of each plant. There are, no doubt, a few places where a combination of central station and private plant service would be the cheaper.

Boiler Room

The boiler room in most private plants is generally the last place to receive any attention in so far as the adoption of modern and efficient methods is concerned. A low type of indifferent labor is also generally found in most industrial boiler rooms. This is most unfortunate, because it is in the boiler room where the greatest loss can occur due to lax methods. The impression seems to be that the only qualification needed for a fireman is the ability to shovel coal. Actually, a boiler should be under the direct supervision of a highly trained man, as the real work of a fireman is to watch and regulate a more or less complicated chemical reaction—that is, the combustion of coal. The chemical engineer would not think of leaving one of his departments, where an important chemical process was being carried on, in charge of unskilled laborers. However, this is exactly what is done in the average industrial boiler room. The result is that loss occurs due to the improper mixing of the two raw materials—that is, air and coal.

Control Instruments

One of the first things that should be done is to provide instruments which will tell the fireman whether or not he is obtaining the right mixture of air and coal. There are several types of these instruments available, some of which are better suited than others for the work. It may be well to mention here that all instruments should be selected with great care. After instruments have been installed, they should receive regular attention from some one man who should be held responsible for their operation. Nothing will cause the operating man to distrust scientific methods more than a lot of instruments in a plant which are out of order half the time. After the installation of these instruments the men should be furnished with short non-technical instructions as to how to use them.

Next to the proper handling of the fires comes the proper maintenance of the boiler room equipment, such as the condition of the furnace brickwork, boiler heating surface, both internal and external, baffles, etc. There are all matters which the test engineer should follow up.

The Question of Coal

Coal is the greatest item of expense in the operation of any power plant. For this reason, it should be purchased with the greatest care. The first question that should be asked in regard to the coal is whether or not the right kind of coal is being used. The price may be right, but the coal may not be the most economical. The selection of coal requires a great amount of careful study, as there are a great many factors to be considered, the most important of which are the type of stoker, furnace, the analysis and the price of the coal. None of these items can be considered independent of the others. It is impossible to give any detailed instructions in an article of this kind as to the selection of coal. However, an attempt will be made to point out in a general way those factors which should be considered. The type of the stoker equipment will decide as to what general class of coal should be used.

After this has been decided upon, the analysis of several coals of this class should be studied. One of the most important characteristics of the coal which should be considered is the heating value. However, the mistake should not be made in thinking that this is the only characteristic worth considering. The percentage of ash has a most important bearing on the value of coal. A paper presented before the June, 1922, meeting of the American Society for Testing Materials, entitled "A Rational Basis for Coal Purchase Specifications," by E. B. Ricketts, treats the subject of the selection of coal in a very thorough manner. A rough rule which may be used is that each 1 per cent reduction in the heating content of a coal reduces the value of that coal from 1 to 2 per cent, and an increase of each 1 per cent in the ash content reduces the value from 2 to 3 per cent. This rule covers increase in coal- and ash-handling costs.

Influence of Coal on Power Plant Capacity

The quality of coal has a very important bearing on the capacity of a plant. There are probably instances where additional boilers have been added when this could have been avoided by changing to a different coal. Even if the new coal costs more, it may be cheaper to use it than to add boilers. It is quite often possible to double the capacity of an existing boiler plant by simply changing the stoker equipment. In view of this, those plants which are pressed for boiler capacity should look carefully into the possibility of changing either the coal which is being used or the stoker equip-

ment, or both, before buying additional boilers and adding to the boiler house.

After making a preliminary selection of coal, it should be tried out in the plant before the contract is signed, as the analysis will not always give an indication as to how satisfactory a coal will burn under actual operating conditions. It may also be well for the test engineer to run a set of boiler tests in order to determine the efficiency, maximum capacity obtainable, etc. After a coal has been definitely decided on, a set of specifications should be drawn up and incorporated in the contract. These specifications should provide for a bonus and penalty if the coal in any particular shipment is better or poorer than that called for by the specifications.

Limitation of space does not permit giving any detailed directions for drawing up a coal contract. This should be one of the duties of the test engineer. When coal is bought by specification, it is necessary that samples be taken from each shipment and analyzed. This should be a very easy matter in a chemical industry where laboratory facilities are available. Although not the largest source of loss, the amount of unburned coal which is rejected from the furnaces should be checked up by taking periodic samples of the ashes and analyzing them.

Treatment of Feed Water

Another matter which deserves investigation in most small plants is the treatment of the boiler feed water. This is a subject which should be of interest to the chemical engineer; and at the same time there may be possibilities of saving if given proper attention.

Considerations of Load

The test engineer should look into the question of the number of boilers which are being used in cases where the plant contains a number of units. The general tendency is to use all the boilers in the plant, although it may be possible to carry the load on a fewer number, resulting in a saving of coal. This, however, depends upon the character of the load. If the high loads are of short duration and it is necessary to carry banked boilers a large part of the time, then the chances are that no more boilers should be fired than are absolutely necessary to carry the maximum load. On the other hand, if the load is very steady throughout the 24 hours, it may pay to use all the boilers in the plant. As mentioned above, this is a matter for the test engineer to study.

Too much attention cannot be given the general appearance of the boiler room. The windows should be kept clean, the walls whitewashed or painted and the lighting properly arranged and kept in good order. If the boiler room is kept in good order and clean, it will be easier to obtain and keep the right kind of firemen.

Engine Room

Although there may be some opportunity for improvement in the engine room, there is less chance for any great loss due to poor operation than in the boiler room. If engines are used, the setting of the valves should be checked up from time to time by the test engineer. In the case of turbines, a careful watch should be maintained over the conditions of the blades, clearances, etc. The surface of condensers should be kept clean and means should be provided for measuring the amount of air leaking into them. The air which can leak through a small pin hole may cause a loss of hundreds of dollars in a year.

Exhaust Steam for Process Work

At one time a great loss occurred in many industrial plants by using high-pressure steam for various manufacturing processes and heating where low-pressure steam taken from the exhaust of engines or turbines could have been used. The exhaust steam from an engine or turbine contains almost as much heat as live steam and thus is almost as useful.

With the development of the bleeder turbine great improvements have been made in this direction. In cases where all the exhaust steam cannot be used in manufacturing processes, the bleeder turbine offers a means of operating the turbine partially condensing, resulting in low steam consumption, and at the same time steam at any desired pressure can be drawn from it for use in manufacturing processes, after it has generated a certain amount of power. If all or nearly all the exhaust steam can be used in processes or for heating, the fuel costs for power is almost nothing, as the turbine simply acts as a reducing value and at the same time generates power. If there is a surplus of exhaust steam, which is either being condensed or discharged to the atmosphere, each process using high-pressure or live steam should be carefully studied in an endeavor to substitute the use of low-pressure steam.

Distribution System

The most characteristic feature about a great many distribution systems is the lack of system. This is generally caused by the gradual growth of the industry. It is very difficult to reconstruct a distribution system without a great deal of expense. Nevertheless, in many cases it is possible to make improvements at a very small cost.

The covering of steam pipes should receive very careful attention, not only in order to conserve fuel but to keep the temperature of the working rooms down to a minimum during hot weather. All steam lines should be carefully drained of condensate. One of the greatest hidden losses in a distribution system is caused by leaky traps. If the system is a large one, it will pay to employ a trap inspector whose duty would be to make periodic inspection of all traps. If conditions permit, the discharge of all traps and any other condensation should be returned to the boiler room and used for feed water. There are several advantages in doing this: First, the water is recovered; second, the heat in the water is conserved; and third, condensation is almost free from any scale-forming elements, making excellent feed water.

Present Status of the Use of Steam

During the last few years great strides have been made in the conservation of heat in various chemical processes. An example of this is the development of multi-stage evaporators in which steam is used to evaporate a liquid, the vapor of which is passed on to a second evaporator, where it is condensed, and at the same time the heat is used in evaporating another liquid. In this manner the heat in the steam is used over and over again in carrying on several distilling operations.

Where an industry consists of several departments, means should be provided for measuring the amount of power and steam consumed by each department. If this is done, excess consumption can be traced.

New York City.

Good Lighting
A Servant That Will Increase Production

Artificial Illumination a Necessity — The Advantages to Be Derived From Good Artificial Illumination — Relative Cost of Good Lighting Referred to the Cost of Labor—The Importance of Proper Distribution

BY CHARLES GALLO
Illumination Bureau, Westinghouse Lamp Co.

IN THE industries, artificial illumination is an investment in superior management. Primitive man with his "pine knot" torch and modern man with his "billion candlepower" searchlight both found and find artificial light a necessity. Notwithstanding the progress which man has made in the field of artificial lighting—a progress whose alpha and omega might be represented by the pine knot with its smoke and yellow flickering light and the modern minute and highly efficient tungsten lamp used on the surgeon's or the dentist's probe—the real need for effective artificial illumination is not always clearly realized.

The surgeon and the dentist recognize and appreciate the value of modern illuminants. The industrial executive, to whom effective and adequate illumination on a broader scale may render as great a service, is frequently too busy with other and perhaps more pressing problems to consider the subject of artificial light. Yet this subject handsomely repays consideration.

ADVANTAGES DERIVED FROM GOOD ILLUMINATION

Briefly summarized, the advantages derived from good illumination are:

1. Increased production.
2. Reduced accidents.
3. Greater accuracy in workmanship resulting in improved quality of the products manufactured.
4. Less eye strain, thus increasing the efficiency and health of the workers.
5. Working conditions more pleasant, with greater contentment of employees and a reduction in the labor turnover.
6. More order and neatness in the plant and pride in its appointments.
7. Supervision made easier.

These advantages are very real and they are obtainable at very moderate cost. The details of working out a satisfactory lighting installation may be delegated to an illuminating engineer, and the manufacturers of lamps are always ready to supply advice without charge to their customers. The executive or manager owes it to himself, however, to see to it that this phase of his supervision is not neglected.

INCREASED OUTPUT THROUGH GOOD ILLUMINATION

Adequate and effective illumination has increased the output of various manufacturers from 5 to 20 per cent. In some cases even higher increases have been observed. These increases are due to the fact that with good light the workmen can *see faster*. The truth of this statement may be easily demonstrated in your own shop. Go near some machine with a fairly large flywheel or gear. The apparent speed at which that wheel revolves will depend on the amount of light that falls on it. Obtain a lamp and a reflector (about 200-watt size) direct a strong light suddenly on the moving wheel, and you will see it *slow down*. Does the speed of the wheel actually change? No! You can *see* the spokes *more quickly* and the wheel *seems* to go slower.

EXAMPLE OF GOOD GENERAL LIGHTING

The same things happen in any operation which requires manual attention. It takes time for a workman to see and to pick up a given tool. Increase the light on that tool and the operation is speeded up unconsciously and automatically. The man moves faster because he sees faster. The truth of this has been demonstrated time and again in machine shops, foundries, textile mills and other industries.

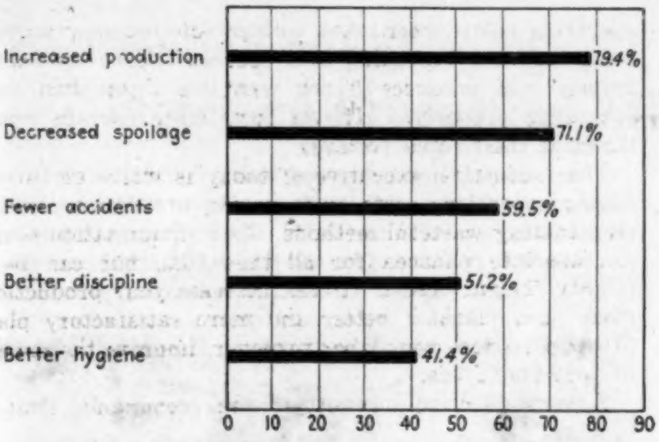
COST OF LIGHTING REFERRED TO COST OF LABOR

Many industrial executives have realized the advantages which good lighting carries with it. They are cashing in on their realization because they have installed modern and effective lighting systems and they will never go back to the old. A few are named:

Phelps-Dodge Corporation, Nocozari, Sonora, Mexico.
Chapman Valve Co., Indian Orchard, Mass.
Millers Falls Paper Co., Millers Falls, Mass.
American Steel & Wire Co., Worcester, Mass.
Alabama Pipe & Foundry Co., Anniston, Ala.
Columbus Forge & Iron Co., Columbus, Ohio.
Conner Steel Co., Birmingham, Ala.

The cost of good illumination will of necessity be variable. Two and one-half per cent of the wages is, however, a trustworthy average figure. Wages represent about 20 per cent of the value of the finished product. It follows that the cost of good lighting is in the neighborhood of one-half of 1 per cent of the value of the product.

We have previously noted that production is frequently increased from 5 to 20 per cent, due to good lighting. Were production increased only 7 per cent,



BETTERMENTS EFFECTED BY GOOD LIGHTING

the money invested in good lighting would be earning interest at the rate of 1,300 per cent. Isn't good lighting an efficient servant?

Accidents and Waste Eliminated by Good Lighting

The report on "Eliminating Waste in Industry" issued by the American Engineering Council's committee attributed industrial waste to a number of factors, among which are:

1. Low production—caused by faulty management, faulty equipment and plants.
2. Lost production—caused by ill health, physical defects and industrial accidents.

The same report stated that the responsibility for over 50 per cent of the waste in industry lay with the managers of the various industries.

Above we have hinted at the fact that managers may decrease some of the waste due to *low* production by improving lighting conditions. Waste due to *lost* production caused by accidents and ill health may also be reduced by good lighting.

Fig. 1 shows how darkness or inadequate lighting and accidents go hand in hand. Accidents are not all due to poor lighting conditions. Statistics show, however, that accidents may be reduced about 20 per cent by improving lighting conditions. Records for the year 1919 show that 23,000 fatal or crippling accidents caused a loss in time equivalent to $853,000,000. If good lighting reduced accidents by only one-eighth this would represent a saving of over $100,000,000. Is that worth while?

In this article we have thus far mentioned good lighting and adequate lighting. It will probably be well to define these terms, to try to explain what is good and adequate lighting.

What Is Good Lighting?

Daylight and plenty of it, shaded and softened, is both good and adequate. How good and how adequate is perhaps best realized by the illuminating engineer, who must try to produce equivalent results, by using that wonderful, if small, substitute for the sun, the modern incandescent lamp. The human eye can, when not imposed upon by glare, adapt itself to operate over a stupendous range of illumination values, and the illuminating engineer can therefore obtain good results with the means already at his command.

Adequate lighting is that which will supply an illumination of such a value as to enable a given operation to be performed most rapidly. Illumination from the quantity standpoint is measured in foot-candles. Ten years ago 3 foot-candles was considered good illumination for weaving operations in a cotton mill or for grinding or mixing in a chemical plant, because any more light was prohibitively expensive. Today 10 foot-candles is considered good lighting for the same purposes, and costs less. It may be that 10 years hence still higher values will be considered desirable. As competition increases and with it the necessity of more and better production, good illumination is found more and more profitable. The modern factory lighting codes such as that issued by the Illuminating Engineering Society give the values of illumination which are now considered adequate for the various industrial processes.

Distribution of Lighting Important

Good lighting combines an adequate illumination with a proper distribution of the light. If you are reading a book or a paper some sunny afternoon, you will probably turn your back to the sun, in order to avoid the annoying glare. If the paper is white, you will move it into the shade. By so doing you improve, in so far as you are concerned, the distribution of sunlight on your reading matter. For this reason bare lamps cannot supply good lighting. They must be equipped with proper reflectors in order to shield the eyes from the annoying and blinding brightness of the lamp filaments and also to direct the light where it is needed—where the work is performed.

Artificial lighting is paid for on the basis of kilowatt-hours. You pay for the same amount of current whether you use it as heat or as light. Since you are purchasing light, the moral would be, get as much of it as possible for a given expenditure. To do that, use efficient lamps. The light-producing efficiency of the modern lamp increases with the size or the wattage of the lamp. Other things being equal it is more profitable to use large lamps and fewer of them, than a multitude of small lamps.

Lighting Trend Toward General Illumination

The trend of good lighting in today's industries is toward general illumination, using large shielded lamps wherever possible. The limiting factor is generally the height at which the lighting equipment can be mounted. For given types of reflectors the ratio of spacing to mounting height is constant and must not be exceeded when good lighting is required throughout a given area.

General illumination is the lighting system "par excellence" for chemical plants. In these plants maintenance of equipment is at times a veritable bugbear. General overhead illumination, by reducing the number

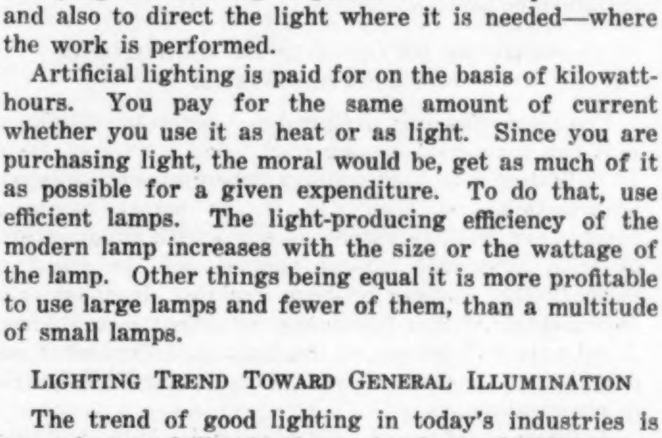


FIG. 1—SEASONAL VARIATION OF FATAL ACCIDENTS

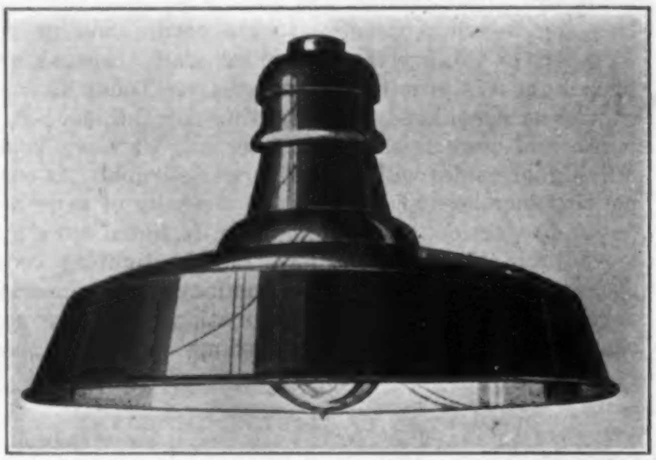


FIG. 2—STANDARD REFLECTOR FOR INDUSTRIAL USE

of outlets, greatly simplifies the maintenance problem, lowering depreciation costs and also the cost of installation.

In such plants good porcelain-enameled steel reflectors, with self-contained sockets such as shown in Fig. 2 will give excellent service. Where corrosive fumes or explosive gases are present in considerable quantities the vapor-proof type of unit (Fig. 3) will give the most satisfactory service.

Points to Be Observed in Maintenance of Lighting System

The most efficiently designed and constructed lighting unit can give good service only when it is kept clean. In buildings with high ceilings, where general overhead illumination and high (18 ft. or more) mounting heights are used, reflectors equipped with pulley-sockets or with automatic cut-out hangers will be found to simplify the cleaning problem greatly. It should also be remembered that where the equipment is kept clean, it not only will deliver all the light paid for but it will also depreciate more slowly. This is particularly true in chemical plants.

Another point worth considering in industrial illumination is the effect of voltage on the light-producing characteristics of modern incandescent lamps. Lamps operating below their rated voltage dissipate current as heat. A lamp operating at 4 per cent below its rated voltage will produce 15 per cent less light than one operating properly. If you buy light, operate your lamps at their rated voltage.

FIG. 3—VAPOR-PROOF REFLECTOR FOR CHEMICAL PLANT USE

The industrial executive of today is interested in reducing operating costs, in increasing production and in eliminating wasteful methods. Good illumination is not an absolute panacea for all these ills, but can be a mighty helpful agent. It can increase your production, make your plant a better and more satisfactory place to work, reduce your labor turnover, improve the morale of your employees.

A very effective servant at your command. Put it to work.

New York City.

Compressed Air as an Aid to Production Efficiency

Most chemical plants have compressed air available for process work. The full compressor capacity is seldom used in the processes; and there is an excess available which may be employed for blowing out pipe lines, cleaning motors and other equipment and for supplying power to various tools used by the plant maintenance department.

There are, however, some other uses to which this excess air power can be put which are a distinct aid in saving man power and increasing the operating efficiency. These uses embody the employment of the pneumatic hoist, an efficient and cheap tool which has not had the general recognition it deserves.

The Pneumatic Hoist

The typical pneumatic hoist has been brought to a a high state of efficiency. The air motor has double acting, cylinders, placed at right angles and operating on a single-throw, balanced crank shaft which is connected to the drive. This drive generally is of the worm gear type, and is cut to a pitch that insures locking of the drum and holds the load at any point, even when the air is turned off or the line breaks. With this feature the load can be raised, the air line disconnected, the hoist run on a trolley, to a distant point, another line connected, and the load placed as desired. Such a hoist can be operated at a cost of less than one-thousandth of a cent per foot of lift per 100 lb. lifted.

Some Uses for This Hoist

One of the most efficient methods of material handling in chemical plants involves the use of electric trucks or tractors and trailers. A good many of the loads encountered are too heavy to be conveniently lifted to the platform of the truck or trailer. If a pneumatic hoist, mounted on a trolley and track, is arranged to serve each station where trucks or trailers are to be unloaded or loaded, this work can be done in the cheapest and most convenient manner.

In many chemical plants we meet the problem of handling large steel drums, which, when loaded often weigh 1,000 lb. or more. It may be desired to lift the empty drum to the filling station, to move it after filling to the heading machine, from there to the scale and from the scale to storage or shipping. Many plants where this is the case are not large enough to warrant an extensive handling system and the air hoist solves their handling problem well.

The Relation of Safety to Increased Production Efficiency

Incentives to Accident Prevention—How Safety Is Achieved in Several Large Industries—Losses Through Preventable Accidents—How Safety Work Increases Production Efficiency

By Louis Resnick
Assistant to the Director, Safety Institute of America

When Judge Gary in 1908 issued the memorable order which started the safety movement not only within his own company but in American industry generally, he had only one thought: to prevent, so far as humanly possible, loss of life or maiming of men through industrial accidents. The humanitarian appeal was the sole impelling motive in the case of practically all of the pioneers in the industrial safety movement.

There were no compensation laws in those days, and if anyone had suggested the possibility of preventing accidents and increasing production by the same stroke he undoubtedly would have been laughed at. The Steel Corporation and the other pioneers in the movement were quite willing to spend millions of dollars to safeguard life and limb in their plants without any expectation of a financial return through increased production. They were, in fact, reconciled to a lowering of production through accident prevention activities, for the earliest safety devices and educational methods were crude affairs.

Incentives to Accident Prevention

As soon as the Steel Corporation had demonstrated that it was actually possible to reduce accidents, industrial men throughout the country began to give serious attention to the accident causes in their own plants and to means of eliminating them. Then came the wave of compensation legislation, a decade or so ago, and this drove thousands of manufacturers who were not inclined to mix sentiment with business into accident prevention work as a matter of self-preservation. Safety does decrease compensation costs, and that fact soon became the second great impelling force in the safety movement in America.

But today there is a third incentive for giving serious attention to accident prevention in industry, and that is the effect of such activities on production efficiency. The chemical and metallurgical industries are rich in examples of safety work which also—sometimes by design and sometimes much to the surprise of the safety engineer himself—increased the production of the individual machine or workman, decreased the production costs through some other means, or increased the quality of the product.

One of the big paint manufacturers set out to eliminate the health hazard to the men in his principal manufacturing department, and in revising its processes with that one end in view, stumbled upon a means of increasing his production efficiency through all three of the channels just enumerated. What started as a bit of safety work in this plant has revolutionized a century-old manufacturing process. Today this company is engaged in tearing out equipment which is being replaced by new machines occupying approximately a fifth as much space and which turn out a better and cheaper product with a very heavy reduction in the number of lead-poisoning cases among its employees.

In the so-called dope room of the Armour & Co. can factory at Chicago there is another good example of much the same thing. In this room there are a dozen or more oven-like machines known as compound driers in which the grooves of can covers and bottoms are coated with a benzene composition. For years this department justified its name. Operators and inspectors at the driers would become "dopey" and frequently would actually fall asleep at work. It was difficult to retain employees in this department, and a great deal of time was lost through headache.

"My principal job," the foreman tells us, "used to be to walk from machine to machine and talk to the operators and inspectors so as to keep them from falling asleep."

Perhaps the most expensive result of this condition was the heavy percentage of defective can covers which were passed by the semi-conscious inspectors. Every defective cover sent to the canning department meant a leaky can and spoiled food. The "leakers" sometimes ran as high as 7 to 10 per cent—quite an expensive item when you consider a production of 50,000 cans a day. Sometimes the room became so full of fumes that the department had to be shut down, and this in turn meant the temporary closing of the entire can factory and the can-packing departments.

Remedy for the Fume Hazard

Then along came the superintendent of the can factory and, independently, hit upon the same scheme that solved a somewhat similar problem at the plant of the Ford Motor Co. He devised an exhaust system to draw off the benzene fumes, the pipes of which ran directly into the drying machine instead of terminating in hoods several feet above the machine, and in addition he installed another set of pipes through which fresh air was constantly blown into the room. This enabled the department to increase its production 25 per cent, to get a much better class of employees, and to retain them; it made possible so much better inspection that this department received a large share of credit for the reduction of "leakers" from an average of 4 per cent to less than one-half of 1 per cent; and there hasn't been a single case of an operator or inspector falling asleep in this department since.

An Example at the Ford Plant

The experience of the Ford Motor Co. presents this example. There is in one of the buildings at the Highland Park plant a department including ninety-seven cyanide furnaces and seventeen annealing furnaces. Up to 2 years ago this department was one of the most troublesome in the plant. The furnaces were heated to 1,560 deg. F. and it was necessary for the workman, standing directly before the open furnace doors, to work in a temperature of 133 to 135 deg. It was impossible to keep men in this department for any length of time, and during the summer months eight to ten cases of heat prostration a day were a common experience. The situation became so serious that the general super-

intendent, P. E. Martin, made a special study of the department and as a result a metal canopy was placed around each furnace, making possible the continuous exhaustion of the hot air. At the same time cold air was blown down on the heads of the furnace tenders, bringing the temperature where the men worked down to 80 deg.

This installation was completed at a cost of $100 per furnace—$11,400 in all. And this is how Frank Donovan, superintendent of the department, described the results: "The canopies have done away with heat prostrations in this department, the labor turnover has been reduced 25 per cent, the output has been increased, and our working force has been reduced 50 per cent. This ventilating installation paid for itself the first month in the saving of labor alone, by enabling one man to take care of two furnaces instead of one as before."

An Example From a Dye Plant

The dye works of E. I. du Pont de Nemours & Co. at Carney's Point, N. J., affords still another example. The operation necessitated the constant employment of two workmen to shovel the material into barrels and their consequent exposure to fumes. During July and August of 1919 work on this operation was stopped; the drying operation was replaced by an automatic machine which discharged directly into carriers, where the material was permitted to drain before being dropped into the barrels; a new neutralizing plant was installed with proper fume exhausts; a new catch tank was installed; and the wooden platforms were replaced with concrete. When the process was started up again in September production materially increased, while the number of industrial malady cases decreased.

Loss Through Preventable Accidents

So much for specific instances. The loss to industry as a whole through preventable accidents and preventable illness runs into billions of dollars annually, and few industries are immune. For instance, every morning when the whistle blows more than a million workers are missing from their benches. Every day 3 per cent of all workers are absent on account of sickness. At the very low average wage of $3 a day this means a yearly loss of over a billion dollars in wages and an additional equal amount lost to employers through the disorganization of their working forces. The waste in industry survey conducted by the Federated American Engineering Societies disclosed the annual loss of another billion dollars through accidents. The full significance of these two tremendous items of loss to industry becomes apparent when we accept the statement of safety engineers and industrial physicians that 75 per cent of all industrial diseases and industrial accidents are preventable.

Production Increased by Safety Work

Probably the greatest opportunities for increasing production efficiency through safety work lie in such simple mediums as lighting and ventilation. The bureau of illuminating engineers of the New York Edison Co., which has conducted a good deal of research along these lines, for instance, reports the following as results of revision of lighting facilities in industrial plants:

Increased production	79.4 per cent
Decreased spoilage	71.1 per cent
Reduction in accidents	59.5 per cent

The library of the Safety Institute of America contains many records of marked reductions of accidents in plants in the chemical and metallurgical industries. Each such reduction spells increased production efficiency. The methods of preventing industrial accidents are neither secret nor mysterious. There are in the United States several national and scores of state or local safety organizations where employers interested in the subject may meet and exchange experiences. There is an abundance of literature on the subject, and several safety museums, the oldest and largest of which is the American Museum of Safety in New York City. The employer who is interested in accident prevention or who wishes to learn of the possibilities in this field today has everything in his favor and nothing to hinder him.

New York City.

The Dollar Side of Safety

In an editorial in the *National Safety News* for June, 1922, Holger Jenson makes the following pertinent comment:

"The idea of safeguarding human life and limb is as old as history, but the introduction of modern machinery brought an economic loss, through industrial and public accidents, that fast became a menace to the nation's future welfare. At first, the safety movement was accepted, not as an economic proposition, but strictly as a humane one. The extensive precautions necessary to prevent accidents meant a financial outlay and were observed only to a limited extent; beyond a certain point safeguarding methods were looked upon as extravagance.

Safety Precautions in a Steel Mill

"I recall a steel mill which reached its peak in the number of accidents, including three fatalities, all within a period of 90 days. Suggestions for the adoption of safety precautions and devices were received by the remark that a steel mill could not be operated without accidents; that it was impracticable to fence in the mill equipment. The workmen themselves showed an antagonistic attitude toward the installing of safeguards. The management, however, agreed to make some of the improvements which, from a humane standpoint, were considered necessary. Great was the surprise when it was found that not only were the accidents greatly reduced, but the output of the plant increased. The company at once proceeded to go the limit in safeguarding and in convincing the workmen of the importance of being cautious—all of which involved a large monetary expenditure.

"After a period of one year, the general manager stated that the money invested to prevent accidents had paid better dividends than any other similar outlay he had ever made for production.

Ventilating System Pays Dividends

"In another case poisonous dust and fumes destroyed the vitality of the workers, greatly reducing production. Working hours were reduced, but still the management had to refuse orders, it being impossible to fill them. The installation of a ventilating system solved the dilemma. In the manufacturer's own words, "Our output is twice as large as before, with the same number of employees; the company and the workmen are making more money than we ever dreamed of and everybody is healthy, happy and contented.' That manufacturer and his employees now appreciate the dollar value of safety."

The Budget as a Means of Industrial Control

Successful Conduct of Business Must Be Based on Facts—The Elements of the Cost of Manufacture—Analysis of These Elements the Basis of a Budget—How a Budget Helps the Manufacturer to Control His Business

BY WALTER RAUTENSTRAUCH
Vice-President, J. G. White Management Corporation.

THE unusual circumstances surrounding the conduct of business affairs during the past several years have impressed manufacturers and others with the fact that many of the rules of business procedure upon which they had depended in times past were not adequate to meet the new conditions. Old standards by which progress was measured, costs determined and results predicted proved faulty, with the result that losses arose where there should have been profits and many business enterprises failed which should be in satisfactory operation today.

It is unfortunately true that overspeculation in markets and inventories is responsible for the situation in which many manufacturers find themselves today. Aside from the fact itself, it is unfortunate because it has misled some to overlook the real reasons which underlie embarrassing situations for which the failure of the market cannot be held responsible. When judgments were based on adequate facts—not mere records, but facts—there were rarely any occasions fo: excuses in regard to lack of profits.

NECESSITY OF A MEANS OF FORECASTING

Many a business man, looking toward the future, is asking himself if there is not some means by which he can foretell and thus control the situations he will have to meet; does a business have to be run on an emergency basis or can it be operated with a reasonable knowledge of tendencies and the consequence of these tendencies. It is no tax on the imagination to contemplate the fact that nothing ever happens by chance. In every field of activity, whether in the chemical labo a-tory or in the business office, there are natural laws of action and reaction which are irrevocable, and success depends upon conformity to these laws.

NATURE OF THE ECONOMIC PROBLEM IN BUSINESS

The chemical and metallurgical sciences have made more progress than economic science because chemical reactions are of relatively short duration, so that facts are immediately discerned and easily impressed upon the mind. In economic science the reactions are of longer duration, covering periods of months, or even years; and the results are often obscure because they are remote from the causes. We fail to appreciate the warnings of our physician because we are not immediately a candidate for the hospital when we do not regulate our diet or procure glasses or take exercises prescribed. I am inclined to believe that the same psychology is operative in our attitude toward business problems.

We seem to need a more fundamental basis for the exercise of competent judgment on business problems. One step toward this end appears to be in the use of a budget system of control by means of which proper standards are set up and performances compared with these standards.

There is scarcely a business enterprise which does not have some method of accounting by means of which periodic statements are prepared showing the results of operation of the business. A careful analysis of these operating statements will show for any business that the elements of the cost of manufacture are as follows:

1. Fixed charges, which do not vary with the rate of production or quantity produced in a given period. Such charges are depreciation, interest on funded indebtedness, insurance, local taxes, salaries of officials and office help, etc.
2. Variable charges, which vary with the rate of production or quantity produced in a given period. Such charges are indirect labor, indirect materials, supplies, sales commissions, etc.
3. Direct materials, varying with the rate of production.
4. Direct labor, varying with the rate of production.

ANALYSIS OF ACCOUNTS

Unless the accounts have been classified with some reference to the uniformity of the items of expenditure grouped under each account, the operating statements must be very carefully examined if a reasonably accurate determination of the above elements of cost is to be made. It must also be recognized that certain major items of expense are of a dual character with respect to their relation to the volume of production. The cost of power, for example, has certain elements which are fixed and others which vary with production. Insurance against fire, etc., is fixed; but employees' liability insurance varies directly with the payroll and hence with production.

The operating statement examined may also contain certain items of expense which are abnormal for the period covered by the statement. Major repair charges, for example, accumulating in any period must be distributed over the time during which the wear occurred. So also there may fail to appear in the operating statement certain charges which should normally appear, but which have been covered by expenditures in prior periods. By the exercise of a little common sense, one may take an operating statement covering a given period and determine the cost items which are normal; and by comparison with the sales accomplished during the period arrive at ratios of fixed charges, variable charges, direct labor cost and direct materials cost, to sales, which are very useful in establishing the essential cost characteristics of the business.

A GRAPHIC ANALYSIS TO FORM THE BASIS OF A BUDGET

These values may be used to set up a graphic analysis as shown in Fig. 1, which relates to a certain manufacturing plant recently examined by the writer. Analysis of the operating statement shows that for a volume of sales of $650,000 the direct labor is $130,000, or 20 per

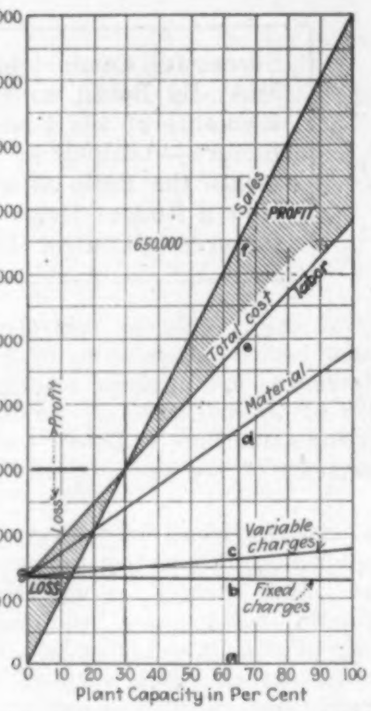


FIG. 1—THE GRAPHIC BASIS OF A BUDGET.

cent of sales. The direct materials cost is $195,000, or 30 per cent of sales. The variable charges are $32,500, or 5 per cent of sales, while the fixed charges are $130,000. The plant is producing $1,000,000 sales annually. These values are set off in Fig. 1 as follows:

Let the ordinates represent dollars value and the abscissas percentage of plant capacity. At 65 per cent of plant capacity, which represents $650,000 sales, erect an ordinate and set off

ab equals $130,000 equals fixed charges
bc equals $ 32,500 equals variable charges
cd equals $195,000 equals direct materials cost
de equals $130,000 equals direct labor cost
af equals $650,000 equals sales

Construct *of, gb, gc, gd, ge.*

How the Graph Is Made

The intersection of *of* (sales line) with *ge* (total cost line) will indicate the volume of sales at which the company will "break even." In this case the sales must be at least $25,000 monthly, or $300,000 annually, before profits begin. This analysis is in many respects very valuable to the plant management. It establishes a budget limit of expense for labor, material and overhead (variable and fixed charges) for different plant outputs, with which the actual costs of these items may be compared and the profitableness of the business approximately established. These budget items may be subdivided to any degree which the requirements of the business may demand, and comparisons may be made not only with the total but with the elements which make up each major item.

Some Uses of the Graph

This analysis establishes the danger point of the business below which losses are incurred. It may be used to determine the effect of changes in material and labor costs, or changes in sales price, on the profitableness of the business. It indicates the variation of overhead with plant output. If, for example, the overhead (variable plus fixed charges) is estimated as a percentage of direct labor cost, it will be found that at 40 per cent capacity the labor cost is approximately $75,000 and the overhead is $150,000, or 200 per cent of labor. At 75 per cent capacity the labor cost is approximately $150,000 and the overhead is $165,000, or 110 per cent of labor. At 100 per cent capacity the labor cost is $205,000 and the overhead is $180,000, or approximately 88 per cent of labor.

If, for example, it has been the custom to base a cost estimate on an overhead of 100 per cent on labor, which may be satisfactory when the plant is operating at about 80 per cent capacity, the same percentage when used for a 40 per cent capacity will result in the determination of a selling price which will not cover costs. Competition may of course fix the price at which goods may be sold, and the situation may have to be met regardless of the plant capacity being used. Nevertheless the facts of the actual costs incurred should be faced, for nothing can be gained by a false method of cost determination.

In times such as the present, when plant output is below normal, it is very important for the manufacturer to know how the overhead varies with plant output, as indicated by the above illustrations. The all too frequent custom of using a fixed percentage for overhead, regardless of output, is very dangerous. The above analysis may be made for each department of a business as well as for the business as a whole. This is particularly valuable in case a variety of products is being manufactured and the profitableness of each line is to be determined from time to time. The industry as a whole may be profitable, yet certain products may be sold at a loss.

An Example From Practice

In a plant examined by the writer some time ago it was the custom to use 100 per cent on labor cost to cover overhead in preparing cost estimates. It was true that for the plant as a whole one dollar was spent in overhead for each dollar of productive labor cost. It was also true that the several products made by the company did not pass through the same departments. Some products were made in departments in which the factory overhead was 300 per cent on labor, and other products incurred a factory overhead of only 50 per cent on labor. The result was that some products were sold at a loss, while others were sold at a high profit; and also that orders were readily booked for the products which were underestimated, and the business in the higher priced products was not readily obtained.

Advantages Following Use of a Budget

There are many factors which control the successful operation of a manufacturing plant, and one cannot hope to correct all unsatisfactory conditions by merely establishing a budget system of operation. It is believed, however, that a prediction of expense items for varying plant capacities, such as is briefly set forth above, will be very helpful to many manufacturers who have never attempted it. Standards will be established which are useful not only in cost determination but also in measuring decreases or increases in given expense items. One never hears of a race being run to determine the distance which may be covered, say, in 10 minutes. The race is run over a measured course. The race for profits is, no doubt, governed by the same principles.

New York City.

Cost Accounting And Factory Efficiency

The Technical Executive Who Uses His Cost System Without Being Dominated by It Is Well Equipped for Intelligent Control of the Factors for Efficient Production and Distribution

BY GEORGE P. COMER
Chief Accountant, United States Tariff Commission

THE basic reason for a cost system in manufacturing establishments arises from the continual development of industrial technique into more and more complex forms. In the days of rule-of-thumb methods both in production and management serious errors of judgment were corrected by personal observation in the plant or sales department. Under modern conditions no such personal contacts can be established, and a substitute for them must be found. This substitute is in large measure supplied by the cost systems in operation in the modern factory. Only rarely, if at all, can the manager follow the daily and hourly movements of materials through the plant in the literal sense, but the "shadows" or "echoes" of the operation may pass across his deck in the form of cost and production records. It is not meant that the management may properly sit at desks a thousand miles away and look at paper slips to the exclusion of actual contact with the factory, but a man with some imagination, corrected periodically by personal observation, may reproduce in his mind a whole series of operations by examining well-organized cost records.

If the development of cost and production records has resulted from the growing volume and complexity of industrial processes, it follows almost necessarily that the records will be more or less behind the pace of industry. During the rapid expansion of the dye business, for example, in 1919 the chief accountant for a large dye plant informed the writer that although he visited the works weekly his records by processes were always several weeks behind the actual methods of operation. For that reason the management was seriously handicapped in correcting errors of production by a study of the paper records. The redeeming feature in the situation was the fact that both the accounting force and the management knew that the records were lagging behind the factory processes and consequently many accountants were employed to keep up with the changes in the plant.

ATTITUDE OF THE MANAGEMENT

If flexible and progressive cost records are required in a modern factory, so likewise must the mind of the man who interprets them be flexible and progressive. This is no place for an essay on managerial qualifications, but the bias of managers is so pronounced in many cases that the best cost system may be rendered nugatory or even positively harmful by the use that is made of it. So well defined are some bias attitudes that textbooks have begun to name them "production bias," "cost bias," "sales bias," etc. Some men, for example, are dominated by the cost records to such an extent that they see no inconsistency in charging, or attempting to charge, $2.50 for a product one month and $3.50 for it the next month. The "cost plus 10 per cent" theory figures out that way, so what more can be done?

On the other hand, many men are convinced that the main function of the management is to sell goods, leaving the weather and the factory superintendent to determine costs. At times, in periods of chaotic costs or uncertain markets, the records of the past or even the cost of the day may be temporarily neglected, but in the long run unless the cost of produtcion dominates the sales policy dividends will fall off. In some cases sentiment or the necessity of a full line may dictate that some products should be sold at a loss, but as a general rule that management is most successful who first discovers the cost of production for all lines and then gradually lops off the unprofitable parasites.

There is a sense, however, in which, under certain conditions, it may be profitable to sell at less than the so-called cost of production. This situation arises when the "marginal cost," as the economist would say, is different from average costs. Every superintendent knows that although the cost of the average product in the factory may be $10 per unit, yet at certain times, especially in slack periods, additional units of the same product may be manufactured for a cost of $5 per unit. Under such conditions it may be advisable to fill some special orders for less than the average cost. Stated in other terms, these marginal orders will be profitable if the price is anything above the actual cost of material and direct labor which go into the fabrication of the article. Stated in still another way, any portion of the general overhead expenses borne by the marginal orders is a gain for the year's operation.

It will be recognized that this obvious industrial fact may cause more harm than good when practiced by indiscreet executives. The temptations to overexpansion, cut-throat competition and ill-advised booking of orders when the factory is already under full production may turn the scale from profit to loss. "Marginal orders" become "average orders" under such conditions, and the full market price must be charged for them. In short, it is a wise man who can use his own cost system without being dominated by it.

COST ACCOUNTING AND THE CONTROL OF PRODUCTION

In order to show the function of a cost system in relation to the control of production it is necessary to outline some elementary principles of cost accounting.

In the first place, cost accounting must not be confused with the regular routine of bookkeeping which most plants carry on. Bookkeeping is a record of the past. Cost accounting is largely estimates for the future. In every well-organized system there are two streams of records flowing side by side, with occasional junctions between the streams. The one stream is made up of the multitude of cost records, which enables the management day by day to estimate the cost of the processes current in the plant. The other stream is the regular course of bookkeeping which, for the most part, records actual transactions. The purchase of raw material, the payment of wages and the cost of repairs

flow along under the hands of the bookkeeper into the monthly trial balances, balance sheets and profit and loss statement. Such a stream may go on with little or no reference to the unit cost of production of particular products. The cost stream is much more intimately connected with the manufacturing processes. Weekly, and daily if necessary, the management may know approximately where it stands with respect to any order on its books.

The two streams touch and, in a sense, become identical at the end of the fiscal period. Cost estimates are matched against actual expenses, and adjustments for errors are made. The ledger record of the past fiscal period becomes the basis for the cost estimates in the future period, and in all cases the basic cost accounts must be closed out into an account representing the cost of the finished product where the cost stream is set over against the income stream from the sales department. This twofold relation of the cost and ledger records is fundamental. On the one hand estimates of the current and future costs must be based on the facts of the past and on the other hand such estimates must be checked against the actual annual expenses when the bookkeeping records are finally closed.

Failure to make such adjustments is often serious and sometimes ludicrous. One company whose books were recently examined by the writer charged to the cost of production interest on the investment for every department in the factory. Having charged the interest to cost, the bookkeepers neglected to tie the cost records to the bookkeeping records by crediting the interest account, and therefore Profit and Loss, with the amount imputed in the cost charges. The result was that they had large hidden profits that appeared nowhere in earnings—6 per cent on the whole factory investment of about $10,000,000.

Basic Schemes of Distribution

To the superficial observer there are almost as many cost-accounting systems as there are independent manufacturing establishments. Each one seems to be different from the other, and in the eyes of the accountant, especially if they have been long accustomed to one system, their own methods seem unique when unrelated to that of any other establishment. To the experienced accountant, however, who is not confused by details, it is equally obvious that fundamentally there are only two or three different cost systems. The chief differences in most systems grow out of the methods of distributing overhead expenses. The costs of material and of direct labor are relatively simple. Therefore they are not the chief points of interest in the system.

So complex is the allocation of general expenses to the cost of particular products, however, that several different schemes of distribtuion are current at the present time. In general these may be divided into distribution on the basis of direct labor, on the cost of material, the value or quantity of output, the departmental investments or the cost of machine operations. Each of these methods may be further subdivided into more refined or, as some would say, more sophisticated processes of distribution. Direct labor, for example, may be considered from the point of view of man-hours or from the point of view of labor cost. Distribution on the basis of material may be either in proportion to the cost of material or to the quantity used. In some cases the quantity or value of both labor and material may be combined in arriving at a basis of distribution. Another method often used in the chemical industry may be called the "process method," by which all possible charges are allocated to different unit processes such as grinding, nitrating and sulphonating, after which the general expenses not chargeable to any process are distributed in proportion to the various process costs in the factory. Perhaps the most detailed and in some respect the highest type of cost accounting grows out of the machine cost method of distribution. The particular type referred to is usually called the "machine-hour" method—that is to say, all possible cost items are centered upon a machine, or more properly upon each type or battery of machines, and the cost of operating one of them for an hour is determined. In some cases the machine operator himself is considered an adjunct to the machine and his wages are charged in with the cost of operating the machine.[1]

The Essential Elements of Cost

The main elements of the cost of operating a given class or battery of machines are as follows: First, the cost of the space which they occupy; second, the fixed charges on the machines, such as interest and taxes, whether they are in operation or not, and third, the direct cost of operating them. These main divisions of expenses are further subdivided into a multitude of items involved in the operation of the factory. Schematically the main elements of cost may be outlined as follows:

ELEMENTS OF COST OF MACHINE-HOUR

I. Space cost:
   1. Interest on real estate.
   2. Repairs.
   3. Taxes.
   4. Depreciation.
   5. Insurance.
   6. Light and heat.

II. Fixed charges on the machine:
   1. Interest on the machine.
   2. Repairs.
   3. Taxes.
   4. Depreciation.
   5. Insurance.

III. Operating charges:
   1. Repairs and depreciation from use.
   2. Oil and waste.
   3. Share of foreman expenses.
   4. Power.
      A. Power cost consists of:
         1. Space cost, fixed charges and operating charges on the machinery in the power plant.
         2. Fuel.
         3. Labor, in power plant.

From the strictly accounting point of view each of these subdivisions of cost is worthy of lengthy consideration, but for present purposes a bare outline of the method of determining the machine-hour rate from these cost elements is all that is necessary. The machine space cost is determined by allocating to a particular battery of machines space charges according to the ratio which the battery occupies to the total machine floor. If a battery requires one-tenth of the total factory space for operations, other things being equal it should receive one-tenth of the space charges. The fixed charges and many of the operating expenses are directly chargeable to the machines. Power is allocated to them by various methods commonly known to the engineering profession. When the total cost of maintaining and operating a machine is determined for the fiscal period the "machine-hour cost" is obtained by dividing the total cost by the number of hours the

[1]It should be understood that in the following discussion the term "machine" is not necessarily limited to a single mechanical unit made up of wheels, cams and pulleys, but it may include a whole installation of process equipment or in fact any arbitrary group which operates more or less as a productive unit.

machine was in operation during the period. Thus if all charges, such as rent, interest, depreciation and operating costs for a machine are $1,000 for a year and the machine was in operation 2,000 hours during the year, the "machinery-hour rate" is 50 cents per hour. In other words, during the subsequent fiscal period each job will be charged 50 cents per every hour the given machine is used on it.

The Departmental Cost Sheet

Having determined the machine-hour rate and caused each production order to be charged with the machine-hours expended upon it, the next step is to assemble the charges against each order in the various departments. For illustrative purposes a hypothetical Departmental Cost Sheet is shown in Fig. 1. It should not be assumed that this exact form can be used in practice, because, for the sake of brevity, more classes of departmental expenses are assembled on it and each class is shown in briefer form than is feasible in practice.

DEPARTMENT COST SHEET

Production Order #1001. Department D.

MATERIAL

Description	Amount	Unit Cost	Value	TOTAL
Total			$20.00	$20.00

Man Number	Machine Number I 1	II $\frac{3}{4}$	III $\frac{2}{3}$	IV $\frac{3}{5}$	V $\frac{2}{5}$	Man-Hours	Rate per Hour	Amount	TOTAL
10	5	3	2	2	1	13	$.50	$6.50	
11	3	2	1	1	1	8	.40	3.20	
12	3	3	2	1	1	10	.35	3.50	
13	2	..	2	2	..	6	.30	1.80	
14	5	3	3	..	1	12	.25	3.00	
Machine Hours	18	11	10	6	4	Labor Cost $18			18.00
Rate	$.25	.20	.15	.30	.50				
Amount	4.50	2.20	1.50	1.80	2.00	Machine Cost $12			12.00
Idle Hours	....	3$\frac{2}{3}$	5	4	6				
Idle Rate	$.10	.08	.04	.13	.20				
Idle Cost	$...	.33	.20	.52	1.80	Total Idle Cost		$2.85	
				Superintendent and Management					10.00
				Other General Expense					5.00
				GRAND TOTAL					$65.00

FIG. 1—A HYPOTHETICAL DEPARTMENTAL COST SHEET

The first significant figure on the Departmental Cost Sheet is the "Production Order Number." The "Production Order" is the beginning and end of real cost accounting. This order, signed by someone in unquestioned authority, starts the process of manufacturing and its final O.K. is the record of a completed job. By it the unending stream of production is broken into sections or units for costing purposes. These units may be determined by a given quantity of output, such as would be occasioned by manufacturing goods to order, or they may be determined primarily by time periods. Each day or each week a new production order may be initiated whose size is fixed by the predetermined factory output for the season or fiscal period. Each order bears a number and all records pertaining to it must show the number in unmistakable figures.

Heading the tabulation of each Departmental Cost Sheet is a record of the material used for this production order in the department. In the lower checkerboard table is the record of labor and machine cost. The columns "machine number" and "man number" record the number of machine- and man-hours required on the order. As a matter of fact, each man number in practice may stand for a whole group of men whose hourly wage is the same and each machine number may represent a battery of "machines"—vats, nitrators or equipment of various kinds.

After the record of each man and of each machine is compiled on the sheet, calculations of costs are made. The total machine-hours for each machine are added in the perpendicular columns and these sums are multiplied by the particular "machine-hour rates," which rates were determined in the manner indicated in the previous discussion. The man-hours are added horizontally and the sums multiplied by the wage rate per hour. By adding these results the total direct labor cost and the total machine cost on this order for this department is obtained. Other departmental charges not included in the machine rate, such as superintendence and management of the factory, may be included at the bottom of the sheet as indicated.

The Costs of Idle Equipment

On this form there will be noted the cryptic expressions "idle rate," "idle cost," etc. These items are sufficiently important and sufficiently different from other cost items to justify their being written in red in practical accounting. They refer to the burden of idle time imposed upon this order by the idle machines and equipment. A clue to the calculation of idle cost is given by the fractional index numbers accompanying each machine number. The fraction $\frac{2}{3}$ connected with machine III for example, means that, in the last fiscal period, this unit ran on the average two-thirds time. The record of idle hours for this production order is derived by the use of this index. Obviously there will be no idle time for a machine when it is occupied on a production order (unless of course there is time occupied in the preparation and setting up of the machine), but each hour a machine works on an order must bear a proportionate share of the idle time expenses for the fiscal period. If a two-thirds time machine is used 10 hours on a job, then the other one-third for idle time must be included in the cost. If it has been determined that the idle rate or fixed charges on a machine is 25 cents per hour and the machine is used 10 hours, then a simple calculation gives the idle charge. $\frac{2}{3} = 10$ hours, $\frac{1}{3} = \frac{1}{2}$ of 10, or 5 hours, and $5 \times 25 = 125$ cents, the idle cost for machine III on this production order. The idle charges for all the other machines are similarly calculated for each particular order and a total idle cost is written in red at the place indicated in the form.

It will be observed that this total idle cost is not carried over into the main cost column for the depart-

ment. It does not follow, however, that the idle charge is not in total cost. As a matter of fact, this amount is included in the machine cost item discussed above. It will be recalled that the total cost of the machine for the entire year was divided by the actual number of hours the machine was in operation during the year. This gave a machine-hour rate which automatically takes care of all idle time charges. If a machine was in operation 2,000 hours out of a total of 3,000 hours for the year, the machine-hour rate would be 50 per cent greater by dividing the total cost by 2,000 than it would be by dividing it by 3,000. These hour rates then, when applied to the machine-hours on this job, give a machine cost which includes the idle time charge.

The reason for stating idle cost separately is found in its paramount importance in factory management. The red figures are a record of inefficiency—a mark of failure as compared with a perfect co-ordination of operating factors.

The Indices of Maladjustment

The indices themselves assume great importance to the discerning manufacturer. Sometimes the idle time charge is large because of business conditions over which the management has little control, but in many cases they hang on month after month because of maladjustments within the factory. Some simple arithmetic applied to these indices gives an interesting result. It will be observed that the least common denominator of the fractions $\frac{2}{5}$, $\frac{3}{5}$, $\frac{2}{3}$, $\frac{3}{4}$ and 1 is 60. If the denominators are raised to 60 the numerators become 24, 36, 40, 45 and 60. That is to say, under the given conditions, if the department had sixty batteries of type I machine, forty-five units of type II, etc., down to twenty-four units of type V, all machines could be run full time so far as the physical organization of the department is concerned. Under the conditions assumed on the cost sheet, however, machine V, operating only two-fifths of the time, can take care of the full-time output of machine I, while number III can perform its share of the operations in two-thirds of the time.

The indices likewise suggest the idea that there are recurring sources of good and bad adjustments within the factory. A given plant with a well-balanced equipment may begin to show heavy idle time charges when enlargements are undertaken, and only after the next common denominator is reached will the balance be restored. It is not implied that in actual practice any such simple arithmetic as this can eliminate idle time, but if the factory is carefully scrutinized for these causes of maladjustment a substantial reduction in idle time charges will result.

Another difficulty met with in the treatment of "idle time" arises in periods of depression under severe competition. It was stated above that the idle time charge is included in the cost of production through the machine cost figure. However, in the recurring periods of depression when competition is keen, these expenses may so burden particular products that market prices cannot be based upon cost figures which include idle charges. When half the looms in a textile mill or half the equipment in a chemical plant is idle, any attempt to make the small volume of products actually sold bear the full overhead charges for the whole plant may result in prohibitive prices. Under such conditions the management should temporarily charge the expense of idle machinery directly to profit and loss rather than in detail to particular products. Here again the executives must be the complete masters, so to speak, of their cost system and must know precisely what loss each underpriced order involves if disastrous results are to be avoided by the competitive price policy.[2]

Cost and Sales Summary

In the previous discussion attention has been centered on a departmental cost sheet. Another tabulation of even more importance than this sheet is the Cost and Sales Summary, in which is assembled the cost of each order from all departments and the sale or market price of the product. Such a summary is illustrated by the form reproduced in Fig. 2.

In the first place, it will be seen that the detailed cost of each production order is shown both by departments and by cost elements such as material, labor and overhead expenses. Beside the total cost for the order is placed the selling price, and this figure is followed by the loss or gain on the order. The idle time charge for each department is repeated and the totals for each job are shown. This is a statistical figure, however, because, as stated above, idle charges are included

[2]From the foregoing discussion it appears that idle time is the *bête noir* of factory management. The writer knows personally of but one case in which idle machinery was a blessing. In a chemical plant near Philadelphia there is one department idle the year round, but figuratively, if not literally, the dust is brushed off the machinery every morning. The product formerly made in this department is purchased under contract from a competitor. Once a year as the time for the renewal of the contract approaches the competitor is given a good lunch and shown through the idle department for a white-glove inspection. The management is then ready to talk business for the coming year.

COST AND SALES SUMMARY

Production Order #1001

Departments	Material	Labor	Machine Cost	Supt. or Mgnt.	Sundry Expense	Total Cost	Selling Price	Loss or Gain	Idle Time Cost	Machine-Hours	Man-Hours
A	$20	$10	$7	$2	$1	$40	....	....	$1.75	30	32
B	25	15	12	6	2	60	....	....	3.00	42	45
C	18	7	5	2	3	35	....	....	2.00	29	30
D	20	18	12	10	5	65	....	....	2.85	49	49
Totals	$83	$50	$36	$20	$11	$200	$225	$25	$9.60	150	156
			Production Order #1002, etc.								
Periodic Summary Jan. 1 to Apr. 30											
Cost ledger estimates	$4,000	$3,500	$3,000	$2,000	$1,000	$13,500	......	......	$1,100	900a	1,300a
Actual costs from ledger	4,000	3,800	2,900	2,200	950	13,850	$20,000	$6,150	1,050	1,350b	1,350b
Error in estimates	......	300–	100+	200–	50+	350–	......	......	$50+	450c	50c

a Actual machine- and man-hours from job sheets. b Full-time factory hours. c Actual idle hours per period.

FIG. 2—A HYPOTHETICAL COST AND SALES SUMMARY SHEET

in the departmental cost sheets through the use of the machine-hour rate.

Other statistical columns for each production order are machine-hours and man-hours. The special significance of these columns appears to best advantage in the periodic summary shown at the bottom of the Cost and Sales Summary sheet. In this summary the whole 6 months' operation is recapitulated and the stream of cost records meets the current of actual cost for the fiscal period. The first line shows the cost ledger estimates for all classes of expenses. The total estimated cost of all orders, for example, according to the cost ledger, were $13,500 for the period. This figure is to be compared with an actual cost figure taken from the ledger of $13,850, or an excess of actual over estimated cost of $350.

The estimated idle time cost is also seen to differ from the actual idle time charge. This discrepancy is due to the fact that the estimating figure was determined from the records of the previous period. A new index to be used next year will be calculated for each machine from the current departmental cost sheets.

The summary of machine-hours and man-hours is also significant. From the cost records the actual machine-hours are much less than the total factory hours. This figure of course is a part of the idle time problem and requires no further discussion. The difference in the man-hours obtained from the cost ledger and the actual labor hours obtained from the time clock is also a matter of interest. Naturally there will not be as many idle man-hours as idle machine-hours, but in all cases there will be a substantial number of labor hours which cannot be accounted for in the production records. This discrepancy is a total loss to the management. Naturally it cannot be expected that every man will work on productive labor the full operating time and if any man's record shows the full time the circumstance is sufficiently abnormal to justify a search for error. If the management cares to go into the detail, a continuous record or index may be kept of each group of men to determine how nearly the labor hours from the production records approach the full factory hours.

Other summary tables not shown here may be compiled from the "Departmental Cost Sheets" in which the efficiency of the plant for the current period is shown as compared with previous periods. When similar production orders are passing through the factory periodically, such as a given kind of paint, dye or heavy chemical, the current records set over against the records of last month and last year are important. The machine-hours and man-hours as well as the idle time charges per unit of product may be shown for each order for various fiscal periods. In short, a panorama of the year's operations may be presented by proper grouping of the essential facts in each period.

From the foregoing discussion it is apparent that a cost system, no matter how well devised, cannot increase the efficiency of the factory unless the management is willing and able to profit by the facts revealed by it. An X-ray photograph cannot mend an aching molar, but it is often indispensable in revealing the seat of the trouble. Cost methods are but one of the tools by which the management probes into the vitals of a business in order to discover the ailing members. The remedies, however, can be administered only by the master who is superior to any of his own methods or systems.

Washington, D. C.

Uniform Cost Systems

Uniform cost-accounting methods have been adopted by approximately 120 commodity lines, according to a survey completed not long ago by the fabricated production department of the Chamber of Commerce of the United States.

According to its report, forty lines have gone the whole distance in the adoption of uniform cost systems and in securing general use of them in their industries; approximately the same number have adopted complete uniform methods and are now facing the important problem of installing such systems, while the remainder have only worked out plans for simplification of accounts.

As shown by the survey, the following commodity lines are successfully using uniform cost methods: Steel barrels, malleable castings, cotton finishers, hosiery, west coast lumber, newsprint paper, printing, biscuit and cracker, portland cement, electrical contracting, knit goods, pressed steel, writing paper, wooden ware, caskets, chairs, envelopes, laundry, millwork, power piping and stoves.

Advantages to Manufacturers

A uniform cost system will give the manufacturer comparable results—that is to say, it will give him assurance that the other manufacturers in his line have included and excluded the same items into costs, that their enterprises have been substantially departmentalized in the same way as his own, that there exists a common treatment of overhead, a tying up of the financial and cost records, a control of raw materials. In other words, when the manufacturer studies his summary of manufacturing cost, he will be able to say that A, B and C are figuring their cost in the same way he is, and that any difference in costs is based on superior efficiency and not because of cost ignorance.

While making the survey, the department received scores of letters from trade associations and individual manufacturers pointing out the benefits of uniform cost accounting. Some of the advantages enumerated are:

1. It strengthens the position of industry in dealing with governmental or regulatory bodies.
2. It inspires confidence that selling prices are determined upon a fair and equitable basis.
3. It solves disputed points of accounting within the industry authoritatively.
4. It makes possible a more intelligent competition.
5. It reveals lines within the industry which have been marketed on an unprofitable basis.
6. It shows the danger line below which goods cannot be sold at a profit; thus serving as an insurer of profits.
7. It acts as a common guide to the value, efficiency and waste of workers, machines, methods, operations and plants.
8. It becomes a reliable guide and basis for estimating prospective business, thus acting as a forerunner for comprehensive production statistics.
9. It furnishes current reports for comparing major cost items with standards which are predetermined and thereby measuring and increasing operating efficiency.
10. It establishes a standard code of accounting practice, so that if your cost clerk or bookkeeper leaves you, his successor will step into a system whose operation has been fully and completely formulated.

In announcing the result of the investigation, the department let it be known that it stands ready to suggest the various means by which interest in cost methods can be aroused so that manufacturers will demand uniform cost accounting, rather than have it thrust upon them.

Some of the Effects of Labor Turnover on Production Efficiency

Lack of Harmonious Relations Between Employer and Employee Is Cited as the Most Serious Deterrent to Industrial Progress — Management's Problem Is to Maintain the Intimate Contact That Fosters Loyalty and Industry

BY PHILIP BRASHER,
Assistant to the President, Tide Water Oil Co.

EFFICIENCY of production has so many perils which beset it that ordinarily the more obvious of them are the only ones given consideration.

First of all, of course, in any organization there must be adequate financial equipment allowing the proper planning to be made and providing the necessary reserves of stock, spare parts and machinery. Operations must be so planned that no unit or component will be delayed by the lack of sufficient other components to make the complete assembled part. I well remember a factory in which I was called upon to inspect and improve production about 15 years ago. This concern was manufacturing hose couplings, and one of the first things that was called to my attention was the fact that the local manager considered that he was improving production efficiency by making up enormous numbers of one or the other components of the coupling, with the result that frequently for a considerable period it was not possible to ship complete couplings until sufficient parts of the other type could be made to fill the order.

EMPLOYER-EMPLOYEE RELATIONS

Most of us know what it is to be hampered financially and to have various and sundry setbacks in our plans, but really the most insidious, certainly the most vexatious and probably the greatest cause of delay in production efficiency is the lack of harmonious relations between employer and employee. The lack of harmony may be indicated in a number of ways, showing itself in the simplest form by excessive turnover, in a more aggravated form by various types of sabotage and reaching its climax in the form of complete cessation of work by strike or lockout. While I speak of the strike or lockout as the "climax," it is a very great question in the minds of those who have made a serious study of the subject whether or not the strike or lockout really results in as large a loss as excessive turnover. The effects of the strike or lockout are so very apparent compared with the insidious losses occasioned by turnover that they might well be likened to an acute type of disease like pneumonia or appendicitis compared with the wasting type of disease such as tuberculosis or cancer.

BREAKING IN THE NEW MAN

Unless an executive has come up from the ranks he can scarcely appreciate the delays occasioned by the constant employment of new men. The new man is, in 50 per cent of the cases at least, an inexperienced man and the foreman has the double duty of teaching the man his way around the shop and also his particular job. Of course, if the new employee is simply a pick and shovel man, he will not require a great deal of instruction but he probably will require an unusual amount of supervision. If, on the contrary, the new man is engaged in any kind of semi-skilled or skilled work, he will certainly need a great deal of both instruction and supervision. A foreman is but human and when he is busily engaged watching one unit of his outfit, it is manifestly impossible for him to pay the proper attention to the others, with the result that the work of a hundred men may suffer more or less while the foreman is concentrating his attention on the one.

As you go up the scale and employ a higher and higher type, the cost and the effect on production efficiency becomes more marked. Take, for instance, the case of employing a new foreman, and keep in mind that the foreman represents the management to the men. He is their real point of contact and no matter what your ideas and ideals are as head of your organization, unless your foremen understand and are in sympathy with them, your men will never know what you really are trying to do. It makes little difference for what reason the foreman previously occupying the position had to be replaced. He may have died, his work may have become unsatisfactory or he may have obtained a better position somewhere else. In any event, he probably knew his department. He unquestionably had certain men in whom he trusted and who were loyal to him. He most assuredly knew many things through experience that the new man will have to learn.

LOYALTY, INTELLIGENCE AND INDUSTRY

There are three outstanding attributes that any executive looks for in his subordinates. The greatest of these is loyalty, the second, intelligence, and the third, industry. No matter how industrious and intelligent a man may be, he is worse than useless if not loyal to his superiors. Therefore if the new foreman comes in from the outside, his job is first of all to ascertain the men in his department who are willing or able—and there is a very decided differentiation there—to be loyal to him. It is certain to take him some time before he can feel sure that he can depend on many of his subordinates. Until he reaches that point he can be of no great value in speeding up production because the men will be suspicious and possibly subconsciously hostile until they decide what type of man the new foreman is.

In order to illustrate the effects of the vicious circle caused by labor turnover, let me cite a specific case. A certain concern was manufacturing rifles for the British

Government. These rifles were inspected before acceptance by a corps of British inspectors, the head of which was presumably a younger son. The British were in great need of these rifles, but the rejections for trifling reasons increased to a point where it was almost impossible to get any of the rifles accepted at all. For example, a rifle which, under trench usage, would probably not last more than 4 weeks was rejected owing to a slight check in the stock which did not in any way affect the serviceability but merely the appearance of the stock.

The general manager of the company, probably not realizing the exact condition of affairs, called the production manager on the carpet and after a rather acrimonious discussion, a new production manager was needed. The new production manager, being a man of a great deal of force and very decided ideas, chose to begin his term of office by a very frank talk with the foremen of the various departments. This talk was forceful and probably effective with a number of them. It proved, however, a little too forceful for one of them who, on returning to his department, vented his displeasure on operative No. 594 who had charge of running five milling machines which performed operations 1 to 5 on the body of the rifle, there being a total of 157 operations on the component part. Operative No. 594 took the attitude that he was not going to have any foreman talk to him in that way and he quit, leaving a vacancy to be filled by the employment department.

Unfortunate Management All Around

This department, on receiving the requisition, employed John Jones, who represented himself as having been a machinist in the factory where a majority of the motor cars of the world are manufactured. The employment department, being very busy at the time, assumed that a man who had been a machinist anywhere would be capable of performing the semi-skilled work of running automatic machines and possibly did not realize that Mr. Jones' experience as a machinist had consisted in tightening certain nuts on the left hand rear wheel of the aforesaid car. Mr. Jones was escorted to the department where rifle bodies were being produced, the five machines were pointed out to him, he was given brief instructions and particular emphasis on the necessity for speed and was left to his own devices.

Until he had to replace one of the cutting tools all went very nicely, but when this became necessary, he unfortunately did not call upon a more experienced hand and attempted to fit the thing himself, with the result that every subsequent cut made was just deep enough to ruin the body completely and as there were over a hundred and fifty operations after this one, all of them were a complete loss and it was some time before the inspector in charge discovered the defective cut. By that time one-tenth of the production of that department for the day had been ruined. The foreman was notified and he very naturally interviewed Mr. Jones and gave him his opinion of his previous training and general character. Jones, being indignant, took it out on his machine and the gears were unable to stand the strain, two of them being smashed. One-tenth of the total production of rifles was thereby put out of commission for an indefinite period. Mr. Jones was invited to leave with dispatch and it became necessary to hire still another man.

As in all efficiently operated plants, the production of one department is ordinarily very much dependent on the production of the department immediately preceding it, and the loss of one-tenth of the production of this particular component was passed along down the line until every department was short at least one-tenth of its productive capacity. The foreman of the body department was called on the carpet with the result that he was discharged also. The resultant delay through all the departments eventually produced the release of the new production manager and so the circle became complete.

The release of the original production manager had worked itself down through the ranks and back up again with a loss of at least 10 per cent of production, two production managers, one foreman, two operatives and unquestionably others indirectly. In addition there was incredible damage to the morale, considerable expense incident to employing the new men, delay necessary to instruct these new men by their immediate superiors, breakage of tools and machinery by the new man and, finally, the spoiled work and decreased production which was inevitable under the circumstances. These are only the results directly traceable to the discharge of the original production manager and it would be impossible to estimate the indirect results. Any experienced man can easily guess how serious they were also.

Getting at the Essence of Industrial Relations

The whole question of proper industrial relationship has apparently won the reputation of being exceedingly difficult and complicated. As a matter of fact, in the writer's opinion, it is so extremely simple that it misleads many into elaborate explanations which do not explain.

Several years ago, while a certain country was engaged in a large war, the Secretary of Labor of that period decided to make a tour of the various industries in the country and give the executives in charge some valuable points on how their industries should be run. It is related that he arrived early one morning at a plant located far out in the middle of a desert, and presumably being hot and dry, the Secretary was not in the best of humor. He was met by the general manager, who expressed his desire to co-operate in every way, but the Secretary cut him short with a curt demand to see the grievance committee of the plant. He was informed that there was no grievance committee, upon which the Secretary burst forth with: "What? No grievance committee? I never heard of such a thing. It is outrageous. I can't imagine a plant without a grievance committee. Have a committee appointed at once to wait upon me at 3 o'clock this afternoon."

The manager went out to the plant, called his men together, stated the case to them and left them to appoint the committee. At 3 o'clock the committee waited upon the Secretary of Labor. "Well, gentlemen, what are your grievances?" said the Secretary. The chairman of the committee was an old Irishman and answering the Secretary of Labor, he said, "Sor, we have no grievances."

"What? No grievances? I never heard of such a thing. It is impossible. How do you account for it?"

"Sor, the manager of the plant, Mr. Coward, knows every man in the plant by name. He's in every part of the plant every day and if any one of us have any

grievances, we step right up to Mr. Coward and talk it out with him then and there. Sor, we have no grievances."

That story in addition to being true has the added merit of stating concretely the essence of industrial relations—contact. In my opinion, it is entirely possible for one man to manage and to keep in touch with a plant of 500 men. It may be possible, although I doubt it, for one man to keep in touch with and manage 1,000 men, but it has been demonstrated to be impossible time and again for any one man to keep in touch with more than 1,000 men if he has any other work to do.

There is a point of diminishing returns in the size of industrial organizations just as there is a point of diminishing returns in any other problem, economic or otherwise. I do not think it can be questioned that a number of our present-day organizations are too large for the men that control them. There are a few men in the country such as Mr. Schwab who can inspire an exceptionally large number of men with profound loyalty and consequently can handle exceptionally large organizations. In far too many cases, however, the executive at the top attempts to depend upon machine-like methods of control, leaving out the personal element entirely and thereby sacrificing the human interest and loyalty of his men. The result is inevitable—increased turnover and decreased production.

New York City, N. Y.

What Is a Living Wage?

In view of recent difficulties between railroad employer and employee there has been some talk of a movement in the Senate to amend the Cummins-Esch act in order to impose more clearly on the Railroad Labor Board the duty of assuring a "living wage." The provisions of the present law under which the board must act in labor disputes are as follows:

> In determining the justness and resonableness of such wages and salaries or working conditions the board shall, so far as applicable, take in to consideration among other relevant circumstances:
>
> (1) The scales of wages paid for similar kinds of work in other industries.
>
> (2) The relation between wages and the cost of living.
>
> (3) The hazards of the employment.
>
> (4) The training and skill required.
>
> (5) The degree of responsibility.
>
> (6) The character and regularity of the employment; and
>
> (7) Inequalities of increases in wages or of treatment, the result of previous wage orders or adjustments.

Discussing the language of this part of the law, Prof. Frank H. Dixon of Princeton, who is a specialist in transportation, has recently made the following statement, reproduced here from the August bulletin of the National City Bank of New York:

> No mathematical rule has been discovered for the determination of a reasonable wage. But so long as we maintain our régime of private industry, one of the determining influences that must be accepted by any wage-adjustment board is the first-named of the seven conditions listed in the statute, "the scale of wages paid for similar kinds of work in other industries." Granted that the statistics of wages have been honestly and intelligently gathered and that no manipulation of wage rates has occurred through undue pressure of combined capital, the price that must be paid for similar labor in the open market is one of the conclusive factors in determining the reasonableness of a prevailing wage standard. Moreover, in connection therewith the board should adjust wages in harmony with the industrial conditions of each locality. Standardized wages effective over wide areas can with difficulty be defended on any economic basis. Their reason for existence is political and strategic. Testimony submitted by the employees themselves in Chicago recently is a virtual recognition of the need of restoring those differentials between town and city and between one section and another that were largely destroyed during the period of the national agreements.

The provisions of the law seem to be comprehensive and reasonable. It is right that conditions peculiar to railroad service should be taken into account, but there is no justification for setting up a special standard of living for railroad employees. The conclusive reason against it is that other people, many of whom have a lower standard of living, would have to pay the bill.

Standards of Efficiency of American Labor

The much-discussed question of the efficiency of American labor, particularly in comparison with the standards of output which prevailed prior to the war, is the subject of a recent article in the *Monthly Labor Review*, contributed by Ethelbert Stewart, U. S. Commissioner of Labor Statistics. Mr. Stewart shows that the basis for much of the current belief that the American workman is not as efficient now as formerly is found in general statements which have no backing of statistical proof. Against this state of affairs he presents considerable data from particular industries showing that a proper consideration of all the elements entering into production does not evidence a general slackening of effort on the part of the workers, but in a number of industries increased efficiency is shown. Mr. Stewart urges the need of time-cost studies as a basis for scientific measurement of labor efficiency, not with a view to "speeding up" industry but for the purpose of establishing a definite standard for judging work.

In connection with the subject of labor efficiency, a review of a recent speech by a prominent coal operator shows the excessive amount of "idle-day costs" in the coal mining industry because of the overdevelopment of the industry which results in the non-operation of many of the bituminous coal mines of the country for a large proportion of each year. The total annual loss to capital and labor because of the closing of the mines for approximately 100 days each year is estimated at more than $400,000,000, more than three-fifths of which represents lost wages. Moreover, no consideration at all is given in this figure to the loss to the general public of the productive effort of this large aggregation of men for about one-third of the working year.

The Industrial Physician

That the introduction of the physician into the industrial organization, often made during periods of stress or to comply with legislative enactments, has produced many interesting and beneficial results is the conclusion reached in a report issued by the National Industrial Conference Board, for the Conference Board of Physicians in Industry, which acts as adviser to the National Industrial Conference Board on industrial medical problems. The physician's work in the organization has revealed to the employer many sources of economic waste and to the worker the unnecessary price he is paying for inattention to his health and the health of the family; while to the physician himself has been given a broader view of the value of his services in creating and maintaining better living and working conditions.

The Increasing Importance of Research Demands That It Be Placed Upon a Stable Foundation, Not Subject to Fluctuations of Business Nor the Whims of a Non-Technical Executive — Creative Research Is Otherwise Impossible

The Relation of Research To Production Efficiency

BY C. G. DERICK

CAN you picture a vehicle making progress whose wheels have no hubs? A modern chemical business without a research organization is making about the same rate of progress. The recent period has been an exceptional opportunity to witness the collapse of business vehicles lacking this hub.

You can picture a vehicle making some progress on the hubs. They will turn over, they will decrease friction. Research organizations can be made self-supporting by the sale of their products manufactured during the developmental stage.

But how much more efficient is the vehicle when the hub is drawing support from the tire and the rim through its spokes. Efficiency is at its maximum: friction is reduced to a minimum. No business is operating at its maximum efficiency if the sales department tire is not properly supported by the operating department rim and these properly connected through the spokes of co-operation with the research hub.

The research hub must firmly surround the axle of finance. A perfect understanding and belief in each other must lubricate the two, while a spirit of service to mankind must drive the whole business vehicle.

In any large industry it requires 5 to 10 years to develop a proper research organization. Unfortunately, it requires a decision of a few seconds to wreck it completely. The form may remain to decay slowly after the spirit of accomplishment has departed. The spirit of a research organization is the difficult motive power that requires years to develop, and all the accomplishments of such an organization hinge upon this spirit. Given the correct type of men possessing the research spirit, years are required to familiarize them with the details of the particular business and to weld them into a co-operative unit of production.

Research Should Not Vary With Business Fluctuation

The research organization is the incubator of all lines of future development of a particular business. For this reason a carefully selected group of men must be left absolutely free to explore in all branches of science that are in any way connected with the industry. These men must have the necessary equipment and surroundings to accomplish their tasks and be guaranteed a permanency by a proper mode of financing that is independent of the fluctuations of business. Indeed, this is true to a lesser degree of the entire research organization, but on the developmental side of the research organization expenses may usually be more closely synchronized with business conditions. The exploratory side of a research organization can absorb limitless amounts of money and usually the results will be directly proportional to the investment when the organization has been properly developed. These facts demand the definite financial policy of creating a fund—yes, an endowment—to carry on this work which is properly balanced against the average earning power of the particular business.

The developmental side of a properly balanced research organization does not, except by accident, create new processes or make fundamental discoveries. It furnishes the machinery for developing into efficient *commercial* processes the useful results of the exploratory side. It can be made self-supporting. It can and should be subjected to correct methods of business control. It should become the training school for plant operators, salesmen, accountants, executives, etc. It must be properly housed and in large organizations have its separate manufacturing buildings where experimental results may be tested out on a commercial scale. It must not interfere with production, it must accelerate production. In other words, it should be a small model of the complete business. In no department of a large industry can the spirit of the industry be taught so quickly. Consider the enthusiasm and intelligence of a staff which had grown up with the processes as they had developed. This condition must exist in the not distant future if we are to meet competition.

The Research Organization

A research organization must be further divided into small groups responsible for the different functions of the laboratory. For example, the exploratory side must be divided into groups centering about strong personalities and the developmental side into the groups—business (including accountancy), research chemical engineering, research operating, chemical (doing the actual research of development), library (controlling scientific and business literature, patents, etc.), research analytical, etc.

The co-ordination of the various groups of such a research department is best brought about by the conference system. Most of the groups should hold regular weekly conferences with a secretary present who records the discussions and conclusions. Concise minutes of these conferences should be placed in the hands of each important member of the group and each of the other group leaders. These group leaders and designated members of their group should be free to attend the conferences of any other group. In this manner the freest interchange of ideas and information is obtained.

When a laboratory process which has business possibilities has been developed by any of the exploration groups, a member of this group may be transferred temporarily or permanently to the chemical development group that will perfect the process and the connecting link be established. The attack of the problem having been thoroughly developed in conferences and the developmental work completed in the laboratory, a process write-up with recommendation as to suitable manufac-

turing apparatus is forwarded to the research engineering group, which draws up a report determining the necessary equipment and locations for experimental manufacture, including a complete cost estimate of the installation. These two reports are forwarded to the research operating group, which determines the material, labor and general operating costs for the manufacture of sufficient batches of products to establish proper operating procedure and costs. The three reports are returned to the chemical development group for comments. In case of disapproval of any report by any group, the difficulties are settled in conference. When final agreement is reached, the research engineering group installs and tests the equipment and the research operating group carries out the operation under the advice of the developmental chemist.

Careful cost accounting is maintained throughout the exploratory and developmental stages. Proper credits are given this expense for the sale of products made during the experimental manufacturing period.

Before the process is established upon a commercial scale, the sales department should have already probed the market for the product with the production of the research department, and now must establish an intelligent sales program. Upon the basis of this program the plant operating and the research chemical engineers lay out the finished plant. With proper executive approval the plant is erected and operated during a test period by the research operating department and when operating normally the research department withdraws, leaving a former member and trained operators in charge of the operations.

In a similar manner members of the research department are transferred to sales, engineering, accountancy, executive, etc., departments and gradually the business is operated by men with a comprehensive conception of the entire business and the requisite sympathy through understanding to force success. Thus the spokes of coordination are developed and the wheel is ready to roll.

Technically Trained Men as Executives!

This is no idle dream. There are organizations in existence built more or less upon this plan. It if takes 5 to 6 years to build a proper research department, other departments are being built simultaneously, drawing the backbone of their organization from the research department during this time. So at the end of the period a complete business structure has been erected.

Is it too much to hope for accountants in chemical industry who are graduates of chemical courses? Is it too much to expect librarians in chemical industry to be graduates of chemical courses? The writer found little difficulty in obtaining such men. And how fast the plant accountants were to draw such men from the research department!

Is it too much to hope that all chemical industry may be directed by executives with chemical training and financed by financiers with chemical training? The conspicuous success of the few daring chemists who have tried these fields is just an indication of the future. The universities must aid in this and the professors of chemistry must stop impressing upon the formative minds of the young chemists that it is degrading to leave the direct paths of chemistry for those of business based upon chemistry. A noble success is the greatest reward of the teacher no matter in what line his students make that success.

The research manager must be a member of the board of directors, as must all of the main heads of the business. He must be more than a consultant, he must have a vote. The financial interests must not monopolize these boards. It is not enough that the members of the board of directors may have had a chemical training, it must include the active chemical and engineering and sales leaders of the particular business. Such a directorate can properly serve its stockholders. The present unrest beween labor and capital would find in such an organizaion one less cause for discontent.

Business Wrecks From Neglect of Technical Man

Of course, most business has been built up around some research, but usually a production and a sales department have been organized and operated long before a research department has been established. It is a peculiar fact that money can be readily obtained to float new enterprises upon someone's say-so that there is a profit in the business. A beautiful prospectus extols the charms, but a critical study of the same by a research expert usually reveals not a single concrete bit of evidence for the claims. When, however, he suggests that the financial interest expend a few thousand dollars to test out the claims, the atmosphere becomes chilly. After an enormous expenditure of money there is built up a business that faces bankruptcy in a crisis. Then the expert is called in. He states that the business is economically sound and that such a sum is needed to work out an efficient process. He does not get it, but may get sufficient to make a start. He tries to repair a broken down machine. He pleads for money to make a complete investigation of all possible competing processes. He does not get it. But if he is financially strong enough, his love of a properly completed job forces him to finance these additional investigations. At a cost only a small fraction of that already spent in process develcpment in the pot-boiling fashion of the plant he determines a new process operating at a fraction of the cost of the going process. Step by step he develops his work to a manufacturing scale. The old process is abandoned and the new process makes a small income on an enormously excessive capitalization. Due to the unwillingness to invesigate thoroughly before attempting manufacturing, a return of 3 per cent during bad business years is obtained instead of 15 to 20 per cent. Industry is burdened with such cases.

Again, a financial executive scorns the opinion of his research and other advisers in the actual work, and he purchases a process. He cannot purchase a trained personnel to operate it under local conditions. In a few months a million dollars has suddenly disappeared from the business. Then the research staff is forced to develop the same product and the business to carry this additional load. Another group of executives swollen by their own importance desires to operate a number of plants which the technical members of the company insist are unnecessary, and in a couple of years several millions of dollars have disappeared. Ultimately through necessity the technical adviser's opinion has to be followed, often after bankruptcy has given control to others and the public has paid the bill.

Again, an organization with a few broken spokes finds an individual who thinks he has arrived and to feather his own nest prevents the results of his experts being turned into marketable products because of some pet products of his own. Millions of dollars are lost.

A sympathetic organization built about a research department could often prevent and usually greatly decrease such losses. The interest on the money squandered by many firms in this manner would support enormous research organizations indefinitely.

Another phase difficult to understand and fatal to efficient research is partly illustrated by the last example. It is more common than is usually admitted that large organizations often prevent the marketing of superior products that their organizations have developed. They put them on the shelves until competition forces their use. They argue that the cost of junking old equipment justifies the end. There is no excuse for doing a thing in a less efficient manner than is known. But the deadening effect of such a policy upon the spirit of a research organization is beyond human ability to estimate.

The Remedy

In what directions can we look for relief from such conditions? Educate the business public to insist upon a research report before investment. A difficult problem! Educate the chemical professor that his students need the principles of economics and business as well as chemistry and physics and that he should not give special courses in cement analysis because John Jones has a cement mill in the neighborhood and will pay his recent graduates over a hundred dollars a month upon graduation. He won't tell the trusting professor that that is all the student will ever get unless the latter makes a good fight. Educate the chemist that if he is to be anything but a glorified laborer he must be willing to enter business like the lawyer, the physician, the dentist and the untaught business man by financing himself at the start and to expect a few lean years. Of course all chemists will not build a successful business of their own, but enough seed will fall into fertile ground to cause scientific business built about research organizations to develop and drive out the inefficient and unscrupulous.

Buffalo, N. Y.

Editor's Note: The subject which Dr. Derick has so ably presented is one which we believe to be of vital importance. Dr. Derick's apt simile that a modern chemical organization without a research department is like a vehicle whose wheels have no hubs is grimly accurate. Yet in spite of the obvious truth, chemical organizations in the interest of a false economy have dispensed with their research organizations during the last few years of stress. This statement can almost be made general, so widespread was the elimination of research men.

Should the Dyestuff Industry Die?

Let us be specific for purposes of illustration. Manufacturers of dyestuffs developed during the war large research organizations. It is an essential in this industry so obvious that even the capitalists recognized it. But at the first sign of depression the old cry was raised—"Where can we cut? We must maintain only that force necessary for minimum operations." Research is not necessary for minimum operations, and so research must go! The ultimate result is inevitable. Instead of being an alert organization, strong in its own right, progressive, welcoming competition because it is ready to meet it, we find a fearsome spirit born. Germany will swamp us. We must have protection, embargo. Foreign patents must be worked in this country or licensed to people who will work them. That this is unnecessary is evidenced by one courageous firm which has been able to sell in Germany. What the dyestuff men need most is not protection or embargo or patent rights—all of these things tend to pamper and nourish the industry artificially—but an infusion of some of the pioneer spirit which will establish confidence in research and a realization that by and through research the industry must emancipate itself or die.

Ready Made or Made to Order

Heavy chemical manufacturers have felt that their processes were so standardized that "fundamental research" was foolish and a waste of time. And yet they have been paying tribute money to those research men who developed contact sulphuric acid, and now synthetic ammonia. Why will they not realize that it is healthier, cheaper, better for the country and themselves in general to invest in research rather than buy it?

Some industries have courage and vision. It is a heartening thing to hear of the establishment of a large research department by the Standard Oil Company of Indiana. Some of the most promising young talent in America will go to it. Our prediction is a foregone conclusion that the Standard Oil Company of Indiana will never be worried by foreign competition, will not have to lobby for protection or embargo even if the Russian oil fields should be run for nothing a month and the American oil fields simultaneously evaporate.

Corporations can now talk about economic inequality and a thousand other misfortunes which militate against them, but some day the public will be convinced that the pinch-penny methods of saving the immediate dollar (which after all is the real reason for no research) is too expensive for it and it will not tolerate a pampering of industrial sloths.

This must not be interpreted to mean that we are not in sympathy with a tariff. But a tariff which protects a growing young industry is a very different thing from a tariff which removes all need for progressive effort and amounts in the end to a tax on the general public for the manufacturer's benefit. Tariff should be a spur to action, a stimulant to progressive effort, and not a narcotic which lulls the manufacturer to a comfortable somnolence and without which he wakes to a whining plea that he cannot live without it.

Co-operation Pays Dividends

There is still another idea which seems to go hand in hand with research and increased production efficiency. It is co-operation. Not long ago a young chemical engineer told us that in his work he had been associated with three separate acid manufacturers. Each surrounded his plant with so much secrecy that practically no one except the men directly connected with each unit knew anything about operation and yields. The operating flaws in one plant were corrected in another and vice versa. The thought which struck this young engineer was, "If they only would pool their knowledge, all of them would be better off." It is so in metallurgical work. A competitor is invariably a welcome guest and metallurgy is an outstanding star in American industries for efficiency and progressiveness. Perhaps it will be the millennium before chemical manufacturers arrive at that same point. Perhaps it won't. For the sake of the industry speed the day!

The Business Cycle as a Factor In Production Efficiency

A Study of the Recurrent Ebb and Flow of Business Activity Reveals Many Practical Ways in Which the Individual Executive Can Forestall the Disastrous Effects of an Industrial Crisis and Depression

BY ERNEST T. TRIGG,
Vice-President, John Lucas & Co.

AN OBSERVANT MAN can scarcely pick up a newspaper or magazine nowadays without seeing the term "business cycle." It has been receiving considerable attention in recent months, especially after President Harding's Conference on Unemployment appointed a subcommittee to study its causes and effects. Many have called such a study "highbrow" and have dismissed it with a contemptuous shrug and perhaps the comment that it was something for college professors to play with, but of no serious consequence to the business man.

But it is the opinion of the writer that it is of vast importance to the business world of the United States—this study of the business cycle. Is the country helpless to prevent it? Have we got to have good times and bad times every so often, willy-nilly? Is there no solution to this problem?

But before attempting to solve such a difficult problem, let us look to the term itself: What is this so-called "business cycle?" Briefly, it is that recurring process of booms and slumps that affects our industry and our business directly, and our agriculture indirectly. Obviously the solution is to lop off from the peak in boom times to fill up the trough in depressions—in other words, to temper an industrial crisis by acting before the crisis becomes inevitable. The idea, then, is to plan for the future by applying a knowledge of the past.

Let me quote from a document which came before the recent conference:

> The vast majority of the unemployed were recently on the payrolls of private business enterprises. These men lost their jobs because their employers were losing money. Over 15,000 business enterprises have been forced into bankruptcy since the present period of depression began, and the number now operating at a loss must be very large. Unemployment on a vast scale is always a result of business depression. The problem of preventing or mitigating unemployment is therefore part of the larger problem of preventing or mitigating alternations of business activity and stagnation.
>
> Such alternations have been a prominent feature of business experience for a century or more not only in the United States but also in all other countries that have attained a high state of commercial organization.
>
> CAREFUL PLANNING DURING THE UPWARD SWING
>
> The business cycle is marked by peak periods of boom between valleys of depression and unemployment. The peak periods of boom are times of speculation, overexpansion, extravagance in living, relaxation in effort, wasteful expenditure in industry and commerce, with consequent destruction of capital. The valleys are marked by business stagnation, unemployment and suffering. Both of these extremes are vicious, and the vices of the one beget the vices of the other. It is the wastes, the miscalculations and the maladjustments grown rampant during booms that make inevitable the painful process of liquidation. The most hopeful way to check the losses and misery of depression is therefore to check the feverish extremes of "prosperity." The best time to act is at a fairly early stage in the growth of the boom.

Business is improving. Times are better. But that is not enough. Business must continue to improve and in hundreds of offices today business men are sitting down and trying to figure out how to maintain the increase in their business that has started.

In the past 20 years we have had five business slumps. Things were dull in 1903; there was a depression in 1904; improvement in 1905; boom in 1906-07; depression in 1908; activity in 1909-10; a minor crisis in 1911; a gain again in 1912-13; a depression in 1913-14; improvement in 1915; uncertainty in early 1916; then the war boom, interrupted after the armistice, 1918-19; then the post-war boom, and finally the depression of 1921. How are we going to make such periods more even—that is, take something off the top of the booms and fill it in the troughs of the depression?

THE WORK OF THE PRESIDENT'S COMMITTEE

The standing committee of the President's Unemployment Conference is trying to answer that question. A subcommittee has been appointed. Owen D. Young of New York, vice-president of the General Electric Co., is chairman, and with him are Clarence Mott Wooley, Detroit; Joseph H. Defrees, Chicago; Matthew Woll, Chicago, and Miss Mary Van Kleeck, New York. The survey of the business cycle has been undertaken by the National Bureau of Economic Research, Inc., of New York, of which Dr. Wesley C. Mitchell, the American authority on the business cycle, is director.

Among other proposals for stabilizing employment, it will take up long-range planning of public works and of construction and maintenance work by private employers; unemployment insurance and unemployment prevention by governmental agencies; depression insurance by private employers; employment offices, public and private; out-of-work benefits by labor organizations; financial devices for controlling the business cycle; and improvement of statistical indices of employment and other "business barometers."

These recurring periods of inflation and deflation in general business are intimately reflected in each individual business, and each individual needs now to study his own business cycle. The organizations which have done this in the past have reaped prompt benefits. Some of these are the Dennison Manufacturing Co., the American Radiator Co., and the American Telephone & Telegraph Co., and a rapid survey of American business shows more than fifty other examples of intelligent anticipation of the business cycle by American business men.

It is worth noting that this intelligent anticipation results not merely in greater security on the job for the employees—and of course the President's Conference on Unemployment is interested in that—but also it has resulted in profits to the employer and work for the

worker, at a time when other people's business was in the doldrums.

There was a time when the country had a financial panic about every so often, precisely as it now has the business depression. But the Federal Reserve system has taken away this threat of financial cataclysm. And so we ask, Why not something to fit the business cycle as well? Secretary Hoover feels exactly that way and he hopes to find the answer by the study in which the committee is engaged.

The Seasonal Slumps

But these larger movements of booms and slumps are not the whole story. In every year comes the minor problem of seasonal intermittency and unemployment. Generally speaking, the summer months, with their slackening of activity, and the vacations, which interrupt the flow of business, are followed by the busy autumn period; after the rush of the holidays comes another dull season.

Particularly building, of course, slows down in winter; manufacturers of agricultural implements have their maximum number of employees in the late winter; automobile building falls off in the autumn. Hosiery, garments, shoes, have two peaks of employment a year—early spring and autumn. Twice as many factory workers are idle in Massachusetts and New York State, for example, at the end of March as at the end of September of the same year. We all know that there is an off-season on the farm after the crops have been gathered and the fruit picked. Road building slows down in winter, and logging camps are idle in summer. The fisheries fall off during certain seasons and so it goes.

Just as some business men have controlled the cycle of their own affairs, so these seasonal waves admit of control within certain limits. How far this policy can be carried by the industrial business man cannot be ascertained until he tries it with his own business. Anticipation of demand, analysis of markets, extra sales effort—all these have been used with surprising success.

Application to the Individual's Business

The important point to realize is that unless the American business man has studied his business over a period of many years and is laying his plans accordingly, he is missing something this year and by that much is the helpless victim of so-called "blind economic laws." Working together, American business men, manufacturers and farmers can do even more. They can deal not only with the management inside their own particular industry but with some of the forces which affect them from the outside. Right here is where the study of unemployment and business cycles may be depended upon to increase the year-around efficiency of production. Already the value of organized effort in modifying the evils of booms as well as of slumps is very clear.

For example, the policy of holding back construction work in boom periods and of expanding plans and equipment in dull ones will enable the business man to take advantage of lower costs at the right time. He will not be paying high prices for material and labor in boom periods by overbidding his competitor. In other words, the business man will not throw away his money in good times, but will set aside a portion of it to keep the industrial wheels going in the off-years, thus creating employment for more men and a demand for more goods.

On the other hand, every mistake in judgment by those responsible for commercial and industrial decisions results in waste. In the year 1921 alone, 19,652 manufacturing and trading companies went into bankruptcy, with liabilities totaling over $627,000,000 and with thousands thrown out of work. Practically every one of these failures was the result of mistakes in judgment. Thousands of other business firms also made mistakes, which resulted in a waste of capital, material and resources and unemployment, but for one reason or another they have not been forced into bankruptcy. The elimination of this waste of capital and resources which is continually going on is one of the big problems of today.

Support and Co-operation Needed

Preliminary surveys already made by the Committee on the Business Cycle clearly indicate that there are many practical constructive measures for stabilizing production and mitigating off-years. Statements of theory and principle are of little value unless they are worked out so that they may be applied to actual business. And that is just what the President's Conference on Unemployment wishes to bring about—to show to the business men and employers of the United States that they have in themselves the power to ward off the business cycle completely, or else so to mitigate its evil effects that only a little self-denial and prudence will enable everyone to carry on until the turn of the business tide. Sound thinking and intelligent planning can largely control the cycles of depression by forecasting the course of business. But how can this forecasting be done? By the use of statistical material placed at the disposal of business men by the government. That is what should be given the industry of this country. If the business men of the United States will give this committee enough leads in successful experiences in stabilizing production and in long-range planning of construction, the way will be found out of the difficulties of the business cycles. Secretary Hoover says:

> The President's Conference on Unemployment has been hampered in its work by lack of definite knowledge concerning the extent of enforced idleness in the United States.
>
> The defects of present unemployment statistics are due to the fact that government departments and other agencies cannot now obtain regular, comprehensive and authenticated information from industry and commerce.

What Secretary Hoover says on the lack of employment statistics is even more painfully apparent concerning the other phases of industry. Present figures on production and consumption are utterly inadequate. They do not cover the field; they do not bring to one business what is going on in another. Such a knowledge is possessed by the few today, but if present plans work out it will be the property of the many.

The business cycle has been for centuries a world-wide industrial problem; a dismal economic phenomenon too long endured by civilization. For the first time in history an organized attempt is being made to overcome it. If it can be done, the credit should go to American inventiveness and persistence.

Philadelphia, Pa.

The Importance of Scientific Control in Increased Production Efficiency

An Analysis of the Reasons for the Comparative Neglect of Scientific Control — A Study of Its Technique — An Estimate of Its Advantages—The "Sine Qua Non" of Increased Production Efficiency

By Charles H. MacDowell
President, Armour Fertilizer Works

OUR first industries were located with reference to available supplies and easy transportation to consuming centers. We used our richest and most accessible raw materials. As labor cost was our greatest concern, we developed labor-saving machinery, and as capital became more available, we adopted large unit and standardized repetition methods. As our supply of technically trained men was limited and as our pioneer experience had developed an ability to simplify and extemporize, our lumbering, mining and manufacturing growth proceeded along practical, hard-headed lines. We laid great stress on immediate costs, with but little regard for the future or for making the most out of what we had in hand. An inspection of the tailings and slag piles of the past shows how crude and "main strength" we were in our methods in mining and metallurgy.

As we worked out our most available supplies and as demand for finished products increased, we went further back into the woods and hills for our materials or increased our purchases of foreign water-borne crude products. We still specialized on the mechanical side. In metallurgy, especially in copper and precious metal recovery, the need for cunning as well as main strength was appreciated earlier than in many other lines, and technical advice was sought and utilized. Other industries have followed in a way and the technologist is now having his day. We are still too much inclined to worship exclusively at the shrine of the "practical" and "self-made," and do not yet fully appreciate that the "know why" adds to the "know how" in arriving at the "how much."

Scientific control in manufacturing begins at the bottom and starts at the top—speaking in a Gaelic manner. If those in top control don't start it, the ones at the other end don't do it. It follows, therefore, that the head executive must appreciate its need and get it under way, and there's the rub—he is the fellow who must be shown. He pitches the tune, he is responsible for results, for the selection of his colleagues, for their ability, capacity, willingness, his breadth and vision is their breadth and vision, his grasp theirs.

Control in Industry Analogous to Orchestra Control

Control is positive in principle and is based on mental, moral or physical characteristics. One of the highest types of control is exercised by the leader of a great orchestra. The individual musicians are thoroughly skilled in the technique of their art and have mastered their individual instrument, and yet must accept the positive control of their leader if the orchestra as a whole is successful. The leader must be able to obtain the hearty co-operation of all members of his organization. He need not necessarily be an expert with a single instrument in the orchestra, but he must know and understand not only the possibilities of each instrument and performer but he must know the effects that may be obtained with the co-operation and combination of the various instruments.

The leader of an industry has the same problems to solve as has the leader of the orchestra. He must surround himself by skilled men capable of the fullest co-operation. They must be as competent to receive direction as to give it. The leader sets the pace and on his ability, capacity, intelligence, breadth of vision, positiveness of decision and general friendliness rests the success or failure of the undertaking. Those whom he leads, those to whom a portion of his responsibilities are delegated, must be under his control, and these men, in turn, must control the actions and operations of their subordinates.

More Advanced Control Methods in Europe Than in America

Manufacturers in Europe, working with comparatively small units and competing for world's business, have been compelled through necessity to maintain a closer day-to-day control of their manufacturing than have many American manufacturers. Our genius has run along the lines of repetition, obtaining our efficiency largely through mechanical means. We have had our home markets to supply. Our buyers were willing to accept standardized products and our greatest industrial successes have come through supplying these. Because American payroll rates are high, we have often placed the type of man in control of our plant management who could best speed up labor handling, who thought out large unit methods of handling to get economies in labor. In many instances such men have not appreciated the fact that there were other elements of cost which might be reduced, through closer study of yields and quality, inspection of incoming materials and the greatest possible utilization of raw materials purchased or manufactured. The time is now here when we must study more closely the control of our manufacturing processes from the scientific and engineering standpoint. Many of our industries are doing this now. In order to bring this about, those in charge of manufacturing must thoroughly appreciate the need of using the scientifically trained man in carrying on actual production in the plant. Such a man today is too often kept in the laboratory, in the office or in the machine shop.

Some of the Technique of Control

Efficient control starts by knowing what you are buying; whether what you buy is best suited for your purposes, and that the specifications on which purchases are made insure such deliveries; by seeing that material is carefully weighed and inspected when it comes into the plant and that shrinkages in handling are known and figured into cost. The ultimate cost of raw materials is fixed by the amount of finished product a

given quantity will make. The original cost may be no measure of final cost. Material that has to be culled before using has added to its cost not only the rejected goods (for which credit may be received) but there is a labor cost and a loss of time, all of which affects costs. Shrinkages are often ignored in factory cost accounting, yet in some industries this item amounts to a very considerable percentage of the raw material cost. Careful inspection of all scales and other measuring or testing devices is necessary to keep them in efficient condition and, what is more, a continuous inspection of the work of the men who are handling these devices to eliminate, as far as possible, carelessness or spite work errors which so often creep into plant handling. Without control, there would be little inspection of machinery, with many breakdowns resulting.

Rigid Inspection by Trained Men

Efficiency in this department comes in such rigid inspection by trained men that the worn parts are always replaced before they break and at times when the machine can best be idle without curtailing output. A mild form of sabotage is not uncommon among present-day labor, in allowing a machine to break down with a resulting rest for all hands rather than reporting its condition so that it might be fixed in time. Efficiency is furthered by good housekeeping, so that from day to day materials are kept clean, in their proper places and uncontaminated, as far as possible, from admixtures with other materials. An intimate knowledge of the composition of each incoming shipment, that the greatest yield may be obtained from that particular consignment, is also necessary. Concise, up-to-the-minute reports of the result of the day's work are needed by the superintendent that he may avoid hidden losses and correct any errors which may have crept into the day's operations. A careful study of what is the largest practical unit to handle a given material is necessary. It sometimes happens that hidden losses result from too large operations more than offsetting the labor gains coming from handling the larger unit. An immense amount of capital may be invested in machinery for a certain operation. The interest charges and depreciation can be charged only against the output of that unit. If its capacity is greater than necessary, it may often stand idle and the operation cost per unit be increased to a point where the job might have been done by simpler methods at a cheaper cost. Machinery operating costs cannot be figured by the job, day or week, but the year's cost must be borne by the total output. It may well be that the greatest economies are lost from treating materials in too small batches, that too much labor is used and unnecessary motions made.

Study of Cost of Multiplication of Grades Essential

The factory makes what the sales force calls for. Careful study of the cost of multiplication of grades on the part of the factory and a forceful report to the sales end as to what these diversions cost in plant operation may result in economies to the business through a better understanding on the part of the distributing organization of the effect of this kind of salesmanship.

We might go on at some length detailing these causes of financial loss, which we all know but of which we so frequently do not appreciate the importance.

Far too many of our plant and department superintendents do not yet comprehend how the prosperity of their companies can be augmented by a greater use of scientifically trained men—men from the technical high and manual training schools as well as from the universities. They are too prone to relegate the chemist to the laboratory and to keep the engineer bent over his drawing board, considering both necessary evils. They are overlooking the fact that these men can frequently be made efficient operating men, helpful in every way to a better handling of plant product. Men trained to analyze, synthesize and properly handle can become of great value to any concern manufacturing intermediate or finished products from raw materials. In order that proper manufacturing control can be exercised by the executives, they must have placed before them periodically a correct cost analysis of the business. Such work must be handled by scientific cost accountants. If it be not accurate it is practically worthless. Each operation must bear its proper proportion of all expense. Adequate depreciation must be charged so that the cost of any machine or even factory will have been written off when it is necessary to renew it or it becomes obsolete. Only by such accounting is the factory executive able to discover unprofitable operations so that he may eliminate them or revolutionize them, till their cost is not excessive. The plant accountant thus becomes a very important factor in scientific control. An organization built up in part and run in part by such men cannot but know daily where it stands, can avoid hidden losses and can carry on a scientific control of its operations which should give it a decided advantage over competitive companies not similarly organized.

Do it right today—post mortems are often unpleasant.

Hearty Support by All Is Necessary

In furthering a scientific control it must be fully appreciated that it must be heartily supported down the line, that each department head, foreman and sub-foreman must know why a certain method is to be followed and be in sympathy with the end sought. He must be kept in a constructive as well as an executive frame of mind that improvements in methods may follow and that he may have opportunity for advancement. The personal side of control is all important.

A leading French official, during the peace negotiations in Paris, ventured the opinion that the greatest loss which had come to Europe as a result of the World War was the loss of command. He believed that, as a consequence, Europe would suffer severely for many years. He had in mind the losses from death and disablement of so many men who were mentally and morally capable of sound thinking and of leadership. He also had in mind the disinclination of many of the rank and file to submit to the discipline necessary to carry on in an orderly way the methods necessary for efficient creation of new wealth. The man with whom I was talking was a liberal in politics, experienced in production and a far-seeing, clear-thinking man.

The attitude of the executive toward those with whom he is associated—superintendents, foremen and workers —have much to do with securing control. Control is essential in the working out of any project.

Scientific, carefully studied, humanized control is necessary if the world is to solve its present problems.

Chicago, Ill.

The Modern Chemical Plant

The Successful Conduct of Industry Today Depends on Good Plant Engineering—Plant Engineering Begins When the Plant Is Designed—The Factors Which Must Be Taken Into Account Are: Location, Layout, Design, Construction and Equipment

By Frank D. Chase
President, Frank D. Chase, Inc., Engineers and Architects

SOME DAY someone will write "The History of an American Industry," and the reader and student thereof will learn some valuable lessons applicable to his own business.

The chemical and allied industries are comparatively unexpanded, although not new; but through the lessons of other industries many manufacturers are going to profit, not only by their own mistakes and those of their competitors, but by the history of other lines of manufacture.

The chemical industry is going to follow other American industries through a period of radical evolution. Nearly every manufacturer, regardless of his product, recognizes this; and the more progressive and far and clear thinking men not only recognize this fact but understand just what this is and what it means to them.

To continue in business, to exist as a going concern, one must meet this revolutionary situation and master it.

Success in Past Due to Horse Sense and Hard Work

For generations American manufacturers have prospered and expanded, and it has not been extremely difficult to do so. The markets for products have grown faster in scores of instances than the manufacturer could supply. Raw material and labor were abundant and cheap. Competition was usually negligible. Horse sense and hard work counted about 99 per cent.

All this is changed. Raw material prices are usually controlled by interests powerful enough to dictate prices. Labor is paid more, is organized and demands, deserves and is receiving more than in the past. Advertising is a necessity. Competition is keen—new plants, some small, many with large capital, are entering the field. Scientific management, in two words, is the summation of this radical revolution.

The Modern Role of Plant Engineering

While horse sense and hard work still bulk large in the successful business—in fact, no business prospers without them—there is one more factor to be taken into account in modern business. This factor is science. We all know that the chemical factory would not function long without the laboratory. This is science. The chemists have developed materials, processes and equipment which can be used only with a knowledge of chemistry. This is science. Your raw materials and your process and finished product are dependent upon chemistry. This is science. There is one other branch of science which is today recognized in almost every industry in this country. I refer to plant engineering, as playing an essential and increasingly necessary part in not only the layout and design of the chemical or other plant, but in its location, layout, design, finance, operation and management. These factors properly engineered make scientific management.

This subject is big enough to fill volumes, so I may only describe briefly and in outline the development of a plant, and while it all seems obvious, I know, from the experience of one who has been laying out plants for 20 years, that a scientific analysis of these factors is, at least until very recent years, usually neglected.

Scientific Plant Development Formerly Neglected

Until within recent years the manufacturer regarded his buildings merely as structures housing the equipment and consisting merely of four walls, roof and floors. Neglect of consideration of the type of building best suited to the occupancy or manufacturing processes was followed by neglect of the arrangement of the buildings comprising the plant or their interrelationship.

The result has been in most plants a hodge-podge of buildings built one at a time without reference to co-ordination of manufacturing operations, without thought for future growth either as a whole or for single units or departments, and without thought, in very many instances, of the physical comfort and welfare of employees.

Development of a Plant

This analysis may be the work of a plant engineering staff or of a consulting engineer. Few corporations can command the exclusive services of engineers of broad experience and for this reason has developed the profession of industrial engineering—i.e., the engineer of industry.

The development of an industrial plant project can best be outlined by the steps to be taken. These steps may be listed in their order as:

1. Location.
2. Layout.
3. Design.
4. Construction.
5. Equipment.

Location

Location should be considered with reference to:

(*a*) Supply of raw materials.
(*b*) Market for finished products.
(*c*) Labor supply.
(*d*) Transportation for raw materials from source to supply.
(*e*) Transportation for finished products to market.

Each of these factors requires careful and scientific analysis.

Raw Materials

Raw materials must be of the proper quantity and quality. The supply must be constant, stable and inexhaustible. Substitutes for materials ordinarily used offer large opportunities for increased production and profits. Industrial chemistry enters into this question very largely. New materials developed through chemical research frequently develop entirely new industries. Many existing industries and most new

industries owe their being to the chemical research of the industrial engineer. Freight rates and speed of rail or water transportation affect the raw material supply.

Market

The market for finished products takes into account the amount of consumption within the economical limits of distribution. This applies to the corner cigar store as well as to the tractor plant which ships to points within a radius of a thousand miles.

Labor Supply

The number of people available in a given section, their nationality, training, experience, education, availability, all affect the labor supply. The steel mill, the foundry or the factory employing men, women or children must be accessible to the type of people whom it desires to employ. Many factories are failures because they cannot obtain the services of the class of employees they require, in competition with other plants in locations more accessible or otherwise attractive to the employee.

Transportation

Transportation as a factor of cost of the product must be considered with reference to both raw material and finished product. Not only are there limits above which freight rates cannot go, but the rail or water service must be continuous, direct and of minimum time. If intermittent, surplus supply must be contracted for and provision made for handling and storage. The ore from the Lake Superior mines and coal to points on the Great Lakes can be transported during only 8 months of the year. Mountains of ore and of coal must then be stored to provide for the consumption of the winter months. Labor can be moved and markets created, but the necessity for and cost of transportation remain fixed, and so are often determining factors in locating a plant. Assuming that the city in which the plant is to be located has been determined upon, it is necessary to analyze the needs of the location within the city:

(*a*) Transportation of raw materials and finished product by water, rail or truck.
(*b*) Labor supply accessible to plant.
(*c*) Transportation of labor within reasonable limits of time and cost.
(*d*) Special requirements such as water, power, coal, sewage disposal and waste disposal.
(*e*) Adequate and suitable shape and size of land for present and future building operations.

It is granted that these points seem obvious, but the fact remains that however important may be their consideration, the failure carefully to consider, investigate and study has resulted in very many poorly situated plants.

Layout

The second part of the engineer's problem is the making of a layout which embraces the following essentials:

(*a*) Delivery of raw materials to plant.
(*b*) Storage of raw materials.
(*c*) Introduction of raw materials into manufacturing process.
(*d*) "Straight line" process of manufacturing.
(*e*) Storage goods in process.
(*f*) Storage finished product.
(*g*) Expansion of each or every department for future needs.
(*h*) Handling of materials through and between departments.
(*i*) Machine layouts.
(*j*) Special equipment—ovens, furnaces, vats.
(*k*) Employees' facilities for physical and mental well being.

A detailed analysis of all these points is a matter of indefinite length and in no two instances are the conditions identical; therefore no hard and fast rules can be set.

A few fundamentals may be mentioned, however, which are universally applicable and which should always be considered.

Elimination of Man Power

On the assumption that somewhere between ten and fifteen thousand dollars can be spent to eliminate permanently the employment of one man, careful consideration should be given to the problems of delivery, storage and handling of raw materials. The use of bridge cranes, gantry cranes, jib cranes with monorails, chutes, bins, vats, tanks, buckets and elevators should all be analyzed and the merits of each one carefully considered with a view to eliminating man power and substituting therefor mechanical handling equipment.

Routing of Materials

The second fundamental is the routing of goods through the plant—in other words, the employment of a straight line flow of materials, or expressed in still another way, the placing of all manufacturing processes in their logical sequence in the plant. It is frequently possible to reduce a travel of goods from raw to finished stages from 1,000 ft. to 200 or 300 ft. of travel. This means reduction in the floor space and cost of handling. Frequently entire departments can be relocated to secure advantageous flow of material and effect reduced production costs.

Handling of Materials

The third fundamental is the handling of parts, either in process or finished. Economy is effected by careful distribution, and an accurate knowledge of quantities required for each operation leads to enormous savings in the amount of stock carried. A lack of materials in necessary quantities and at the right place makes a delay in filling orders and a consequent loss of time that could be entirely eliminated by a careful study of the materials required and the location at which they are needed.

Automatic Equipment

The fourth fundamental is the use of modern equipment. This means equipment by the operation of which savings in man power are effected. A machine which will save the permanent labor of one man can well be installed at a cost of ten or fifteen thousand dollars and there are new plants where large economies could be effected by modernizing the equipment. Instances can be cited by the score where production has been doubled by the installation of labor-saving equipment and machinery. The result is larger wages to the employees, the larger wages being cheerfully paid to increase the production without the making of other capital investment, such as larger floor space, to obtain the same reduction.

The fifth fundamental is the introduction of new processes or equipment developed for special purposes.

This is so obviously a specialized problem that generalities are valueless.

Considerations of Welfare

The sixth fundamental is the consideration of the welfare of all employees. This involves the question of better surroundings with abundant light and air, adequate rest rooms, lunch rooms, recreation rooms, retiring rooms and other rooms for mental as well as physical well being and development.

Volumes have been written, and are being written, on each one of these phases of industrial development. The solution of these problems makes for the welfare of every man and woman connected in any way with industrial operation, and it remains for those in responsible charge of industrial operations to make the most of this opportunity for the good of themselves, their industries and their country.

Design

The physical plant which comprises the buildings can be determined after the layout is made. First must be determined the necessary clearances, both vertical and horizontal. This means heights necessary for manufacturing purposes, including vats, tanks and piping. It also means the shape of the cross-section of the building which is necessary to give these facilities and at the same time to provide light and ventilation. This means warmth in winter and coolness in summer. This is not always easily obtainable and it is only through experience and careful analysis of governing conditions that a satisfactory solution may be obtained. For instance, a foundry requires better ventilation than a machine shop, and in turn a machine shop with its equipment requires better light and ventilation than a plant in which there are comparatively few operatives. A chemical plant requires, as a rule, a maximum of ventilation to comply with increasingly rigid state laws.

Light and Ventilation

It is obvious that both light and ventilation may be classed as natural and artificial. Natural ventilation depends entirely upon the contour of the building, as does natural light. There are many instances where artificial ventilation is beneficial to the manufacturing process, as well as to the operatives. Proper artificial light is responsible, as tests have conclusively proved, for 15 to 25 per cent in increased production. Good lighting therefore means a good investment. Proper ventilation means increased production.

Heating of Buildings

Heating is akin to ventilation and a uniform proper temperature must be maintained in order to obtain maximum production. The question of heating involves that of power, and there is a nice balance to be determined between the costs of heating with purchase power versus heating plus manufacturing power. The engineer must be competent to make a careful analysis of heat and power costs. In this connection, too, are involved the use of steam, air and electric current for power and heating.

Sanitary installations must embody the up-to-date features which mark the modern building. Consideration is due this subject from the standpoint of health and happiness of the employees.

Buildings may be built of timber, steel, concrete or a combination of these materials. The market price of the materials, the rates of insurance, the anticipated life of the buildings and charges for maintenance and depreciation are all items to be considered and each individual case must be settled on its merits. The days of flimsy firetraps for the occupancy of human beings are rapidly passing and the science of fire protection and prevention not only means adequate protection for fire-fighting facilities, including standpipe, sprinklers, hose connections, etc., but also the consideration of fireproof partitions, inclosed stairways and proper spacing of buildings with ample entrances and exits.

The question of design cannot be passed by without a word regarding the desirability of worthy architectural treatment. It costs no more to design an attractive building than a building which is ugly, and the basis for an attractive plant is an attractive building. The modern industrial building is frequently as attractive as a modern hotel or apartment house, and deservedly so. The morale of an entire organization is lifted and benefited by attractive surroundings. The worker acquires a pride in the plant where he works which is attended by a definite improvement in production and loyalty.

A further advantage to be derived from the attractive plant, and one to which far too little notice has been given, is the advertising value inherent in it. A photographic cut of an ugly, ramshackle or unkempt factory would do anything but establish the prospective buyer's confidence in the product. On the other hand, a good product has a natural mental association with a good-looking plant. Also, travelers passing a plant of good appearance retain the picture and the company's name imprinted on their memory, while the plant of undistinguished appearance soon fades from the mind.

Construction

The proper construction of a plant means the execution economically and in a minimum amount of time of the plans and specifications of the designing engineer. The method of execution of construction varies, obviously, with each job and is dependent on factors of materials, labor costs and supply. Nothing is gained by the employment of irresponsible contractors, or in an attempt to curtail costs below a reasonable figure which must include a legitimate profit to all parties concerned.

Equipment

Equipment installation has been mentioned in connection with plant layout, and the only comment necessary is to emphasize the point that modern labor-saving equipment frequently means the difference between profit and loss. No manufacturer can afford to keep in his plant a dollar's worth of equipment which does not show a profit, and he cannot afford not to purchase new equipment when the further investment shows a saving of labor or material costs which will result in profits on the capital invested. This is the essential of equipment.

The elements of a successful business are—plant, equipment and personnel. It is only when these three essential functions are co-ordinating properly that we have successful operation—i.e., low cost production—and all of the elements which have been discussed in various paragraphs above are worthy of serious consideration to the attainment of this end.

This is the science of man and material—mental and physical. The co-ordination of these spells success in plant operation.

Chicago, Ill.

Increased Efficiency Through Industrial Training

The Training of Foremen in Production Methods Offers the Best Opportunity to Enlist the Key Men of Industry in Teamwork, Loyalty, Watching Costs, Cutting Wastes and Increasing Quality and Quantity of Product

BY B. M. NUSSBAUM
Vice-President, Business Training Corporation

TWO years ago a large sugar refinery on the west coast became interested in industrial training. It was frankly looking for some plan that would raise the level of efficiency of its force and enable it to introduce economies that the descending business depression made absolutely necessary. The management finally decided that foreman training promised the largest measure of results. A program of 3 months' intensive drill in production methods was accordingly adopted, and more than 200 of the foremen and leading men were enrolled.

At the time this course was being given the refinery was running full capacity and full force, but a few months later the demand fell off sharply, production had to be reduced to 1,000 tons melt per day, which is about half the normal capacity, and of course this meant that a considerable number of men had to be laid off. There came a time last fall, however, when a sudden spurt in market demand called for a quick temporary increase in production. For 2 weeks it was necessary to raise the production to 1,400 tons per day.

It may seem a remarkable statement, but the simple fact is that this sudden 40 per cent increase in production was accomplished without making an increase in the force. The foremen displayed a brand of resourceful teamwork in meeting the emergency which exceeded the superintendent's highest hopes, and the production was got out on time and up to the highest standards of quality. The superintendent attributes the showing made in large measure to the industrial training program which had taught the foremen how to pull together, and the principles of which they were quick to apply under the severe strain of an emergency.

INCREASED PRODUCTION FOLLOWING TRAINING

Production in the rolling mill of the National Stamping & Enameling Co. at Granite City, Ill., increased 34 per cent after the company had installed a system of foreman training. This statement was publicly made by an official of the company at a convention, and he attributed the increased production largely to the greater teamwork and individual ability developed among the foremen by their training.

Swift & Co. have applied foremanship training on a truly comprehensive scale, nearly 5,000 of their foremen and other production executives in twenty-eight of their plants in the United States and Canada having followed through to completion a course in production methods. This company's experience records many examples of efficiencies accomplished through the effects of the training. An outstanding example is given in the production record of an Eastern plant, where one department manager by applying principles drawn from his training increased output from 400 units per man to 700.

In a paper mill the production of one department was increased 42 per cent through an improvement made by a foreman after he had been a short time in a training course. The foreman frankly admitted that the improvement had been suggested by what he read in one of the textbooks of his course.

Many more examples might be cited to illustrate the effect of training on ability. In many cases the concrete result is an improvement in the quality of the production. In others, as in those cited above, definite increases in output are attained. In many more it is impossible to trace concrete results that may be set down in exact figures. Here the influence of the training shows up in better human relations within the plant, more capable handling of the men by the foremen, a stronger loyalty to the plant organization as a result of the clearer understanding of what the organization is, better teamwork all around as a result of the keener sense of one's place in industry as well as better understanding of the production principles and methods taught. Very often these intangible fruits of training, which do not lend themselves to recording in the cost sheet or the profit-and-loss statement, really affect costs and profit and loss in a way that is far reaching and undeniable, even if indefinite.

WHAT IS INDUSTRIAL TRAINING?

Perhaps it will be worth while to consider the type of education that has produced such results. Industrial training is a broad term, and may mean different things to different people. The education embraced under that heading may range all the way from highly technical instruction in technological subjects to elementary education in reading and writing such as is given by some plants in night schools for the benefit of foreign employees. But strictly speaking, we rule out classes in general subjects as belonging to common school education, and all the higher technological training as being really professional or engineering education, and what is left we classify as industrial education in these two classes:

1. Vocational and continuation courses in the plant or under its auspices. Such courses are intended mainly as preparatory, to break in new employees, fit beginners for jobs, and prepare present employees for promotion or assignment to other work. Examples of how this training is organized may be seen in apprentice schools, vestibule schools, shop schools, continuation schools, and the like.

2. Training in the job and on the job as an integral part of the operation of the plant. The object here is not primarily to break in beginners or to fit employees for promotion, but rather to give the individuals in the organization an understanding of their work and of its interrelations in the plant and in industry, to inform

them of the basic principles and approved methods of production, to motivate them for greater efficiency, and to stimulate them in accomplishing it. Of course not every training system accomplishes all of these results; some may narrow their purpose more than others. Examples of this training are given in the production classes and study groups organized in a number of industrial establishments within the last 5 years, and more especially the courses in foremanship training.

Of all this educational work, foreman training is to my mind the most important and the most resultful. All industrial training has value. There can be no question that if a suitable training program is intelligently applied to any group within a plant, the results will be beneficial to the individuals and to the plant as a whole. But I know of nothing that will work such results as a system of foreman training, carefully adapted to the requirements of a given group of foremen and systematically followed by them. The foreman is the key man in industry. It is difficult for the men of a department to accomplish improvements without the leadership of their foremen. It is practically impossible for them to make much headway without his sympathy and encouragement. All of the examples of increased production cited at the beginning of this article are results of foreman training.

Why the Foreman Is Important

"Most of the improvements, policies and ideas of a company stop at its foreman," said H. L. Willson, vice-president and general manager of the Columbia Graphophone Manufacturing Co. "They are not transmitted to the rank and file of employees. The most elaborate safety campaign may be entirely negatived by a careless and indifferent foreman. The most convincing health campaign may be rendered futile by the foreman with a sneer. The most patient study of operations and most scientific reorganization of working methods may be entirely wasted by the foreman who tells his men to 'fergit it' when the reorganizers are on the other side of the door. The smoothest and most successful of production routines may be disorganized or smashed by the whim of a foreman who is ignorant of the working of the whole plant. The friendliest kind of relations between executives and employees, the most careful of employment methods, may be wiped out and a high labor turnover piled up by a tyrant foreman. The most enlightened and earnest labor policy may be distorted into an object of bitterness and resentment by a few words from a cynical foreman with a grouch. In every phase, at every point, the work of the executives may be made or marred by the foreman."

And the opposite of this picture is also true. If the management has a new working plan that it wishes to put across with the force, if it has a new schedule to be installed or a revision of rates to be announced, it can have no better ambassador to the men than a foreman who is clearly informed of the management's policy and in intelligent sympathy with its plans and purposes. The necessary salesman of new ideas within the plant is the foreman.

The head of a large textile company estimated recently that his company saved more than $100,000 in 1921 through improvements resulting from employee suggestions. These suggestions, he says, were in large measure the result of good foremanship. Most of the suggestions really came from the mill and department heads and their assistants, and the remainder came from the rank and file who through better foremanship were stimulated to better teamwork and more intelligent thinking about production problems.

Production efficiency comes from the maximum utilization of men, machinery, methods, materials and money. The foreman does not have committed to him much direct spending of the firm's money, but he is directly responsible for the utilization of the four other elements enumerated. And by his handling of these elements he influences the spending of money.

When training is applied to the foreman, therefore, it is applied at the most strategic place in the entire plant organization. The foreman in the average American plant is the management to the men under him. They judge the management by their foreman, and their respect for and loyalty to the plant is in direct ratio to their attitude toward their foreman. Train a foreman, and you not only put a key man to thinking intelligently in terms of production efficiency, but you can be certain that the men under him will also receive some of the foreman's training. He will pass it on. As the personnel manager of a Western plant put it, in describing some of the results of a foreman course in his organization: "The foremen become instructors and inspirers of their men in the training. Each foreman becomes a center for its propagation. Thus, through the foremen themselves, the ideas reach the rank and file."

Four Kinds of Training

After a plant management has decided to provide training for its foremen, the problem is by no means settled. What kind of training? The choice is a wide one. There are highly technical courses, popular lecture courses, round-table conference systems, extension courses provided by universities, standarized courses, individual plant courses conducted by the management, courses conducted by outside training organizations. While there is this apparent great variety, it is possible to classify the various systems into four groups:

1. *Company Training Systems.* Several industrial companies have organized and conduct training for their foremen. Examples are the General Electric, Goodyear Tire & Rubber, American Steel & Wire, and International Harvester companies. For the most part, these courses are fairly technical, and, while comprehensive, stress the individual processes and problems of the particular industry.

2. *University Efforts at Foreman Training.* Some of the universities that are located in industrial cities have taken up this problem. An example is the work of the University of Pennsylvania, under Prof. Joseph H. Willits. Meetings were held in the auditorium of one of the city high schools attended by about 500 foremen selected from different industries in and around Philadelphia. At each meeting there was a lecture on some industrial topic. The lecture lasted from 35 to 45 minutes, after which the meeting broke up into smaller groups, each group adjourning to a room in the building for discussion and questions. A mimeographed digest of the lecture was distributed among the foremen a week in advance, thus giving them an opportunity to prepare themselves somewhat on the subject to be discussed.

3. *The Informal Conference System.* This is the plan for foreman training proposed by the Federal Board for Vocational Education in November, 1919, and it has been applied in various ways in a number of industrial plants. In brief, this is a system of periodical meetings of the foremen in small groups under a leader for informal discussion of plant problems by the foremen themselves.

4. *The Standardized Course.* Here the training is based on a standardized course which makes use of specially prepared textbooks and requires problem work. It is usually conducted by some outside training organization. In some of these courses lectures are used to reinforce the textbooks, and also to tie the training directly to the work of the individual plant, as well as to bring an element of inspirational leadership into the course that mere textbook study or classroom routine cannot give. An important feature of this system also is the group conference for questions and discussion.

Some Differences in the Training

Each of these four methods of training has its advantages and its disadvantages, and before adopting any system a careful management will give close attention to the differences inherent in these systems and to the special requirements of his own foreman-training problem.

There is one conspicuous advantage of the company course. It is planned especially for its own organization, built with one specific industry and group of foremen in mind. Too often this advantage is lost by overelaboration or too much specialization. The creation of such a course is, moreover, expensive and venturesome. Such a project should not be entered on without the most careful planning and balanced execution on the part of those intrusted with the training. Foreman training does not mean highly specialized instruction in the technique of the industry. In the temptation to make it highly technical lies the great danger in planning any foremanship course—and very often it is just this overemphasis that handicaps the success of a company course.

Universities have the advantage of organization, prestige and, to a rapidly increasing degree, experience in the field of business and industrial education. For picked foremen of an exceptionally high type of mind, lecture courses by specialists on the various subjects of industrial management may be extremely helpful, informing and stimulating. But for the average foreman they are no substitute for courses conducted in the plant or near to it, and therefore under less formidable auspices than the name "university" suggests to the average man of mechanic type. Moreover, the method of instruction, while suited to the exceptional foreman, would soon lose the interest of the average. Few managers regard this plan as a satisfactory substitute for organized training in the plant.

The Federal Board plan is the very opposite of the highly specialized comprehensive course, and it has the advantage of not being complicated or cumbersome in installation and operation. Nor is it expensive. It has the further advantage of being easily focused on plant processes and problems. But its very informality of study material and method involves a serious weakness in that only the exceptional foreman can be brought to make the most of a conference. In a typical group of foremen, meeting together with their feet under the table for free and easy discussion of plant problems, one or two natural-born "talkers" will monopolize the meeting. The rest of the foremen will sit around, silent for the most part, occasionally putting in a word or a laugh, maybe, to show some apparent interest in the meeting; but in general they will get little out of it. If any real ideas are developed at such a conference, too often they are just so much talk to a majority of the men and fail to sink in. The typical foreman is a slow thinker; he learns for the most part by the slow process of experience. That is why any process of training that requires the quick reaction of mind to mind in the hit-or-miss discussion of a round-table conference is less successful with foremen than one which organizes the study material onto a form easy to read and understand, and then adds to this simplified presentation some incentive to follow the study and apply the principles and methods taught.

This brings us to the standardized course. The standardized course deals with the problems of foremanship in terms of basic principles, and seeks to lay a broad foundation of fundamental facts of industry and of human relations within industry that will help the foreman to function better no matter what size of type of plant may be the scene of his foremanship. It is my belief, based on several years' experience training foremen in several hundred industrial plants of the United States and Canada, that the standardized course offers the manufacturer or industrial executive the most competent and practicable means available today for developing foremanship ability. The system has been used in practically every type of industry, it is elastic and easily adapted to various sizes and types of plants, and lays a foundation of basic knowledge about production work upon which more advanced educational efforts can be successfully built. Perhaps the only disadvantage ever voiced against this system was by those who wished a course built especially for their plant and who objected that the standardized course was too general. By reinforcing the study work with lectures given by men who are capable teachers, this objection has been overcome, and in hundreds of plants the standardized course has been focused upon the individual problems of the plant, with results truly remarkable.

Four Training Essentials

In the organization and operation of a successful standardized course, four elements have, in my experience, been found essential to the best results: (1) Text material containing the basic teaching of the course written specially from the foreman's angle and in a style easily grasped by the average foreman type of mind. (2) Lectures in amplification of the text material and applying the principles and methods taught to the processes and problems of the individual plant; an essential feature here is the personality of the lecturers—they must be men who not only know industry and production methods, but also have teaching ability. (3) Problem work calling for definite home study on the part of the foremen-students and giving them experience in applying the production principles taught. (4) Group conferences for discussion of the principles and methods taught in the course and for clearing up questions that arise.

Text, lectures, problem work and group conferences must not only be properly balanced, but the foundation of success in such a training system lies in the proper choice and presentation of the subject matter. As I have said before in this article, foreman training does not call for highly specialized instruction in the technique of the foreman's job or department. The average foreman is pretty well informed in his own line of work. He knows his machine, his process, his department better than any one else—at least, he thinks so—and is apt to resent anyone's coming in to teach him his own job. But when you come in to tell him how other plants are managing, what foremen are doing to meet their problems of organization, discipline, spoilage and the like in other industries, you immediately get a reaction. The foreman is interested in these concrete examples; and unconsciously he is influenced to apply these new ideas to his own production problems.

One of the executives of Swift & Co., discussing this question of what material should go into a foreman course, said: "Let him find out how other plants are managing men, selecting, disciplining and training them; how they are keeping track of materials, learning costs and eliminating wastes; how they are organizing so that the functions of each man fit into those of his associates, thus making for better teamwork. Let him find out these things, and he will rise above the walls of the rut he has dug and see possibilities in his job that he never dreamed of. He will learn that there are ways of doing his daily tasks better than he has learned to do them; that the responsbilities of his position are really greater than he imagined. And his ambition, pride, alertness will be aroused; he will produce more for himself, and in so doing produce more for the company."

PROOF THAT FOREMEN WILL STUDY

A short intensive course, organized and conducted as suggested, sustains the interest of the foremen students to a remarkable degree. One of the stock objections to foremen training has been that foremen won't study. They may attend lectures, they may sit in at conferences, say these critics, but very few of them will really apply themselves and study. I have records of foreman training in more than 300 plants, in groups ranging from several hundred down to less than a dozen; in only 6 per cent of the plants do the results show a completion record of less than 50 per cent; in the majority the percentage is far above that figure. From these records I cite the following examples from industries that may be of special interest to readers of *Chemical & Metallurgical Engineering:*

	No. of Men Who Enrolled	No. of Men Who Finished	Percentage of Men Who Finished
Carpenter Steel Co.	69	63	91
Corning Glass Co.	244	232	95
Detroit Steel Castings Co.	28	25	90
Federal Rubber Co.	93	81	87
Gutta Percha Rubber Co.	128	116	90
Portsmouth Cotton Oil Co.	24	23	98
Simplex Wire & Cable Co.	35	34	97

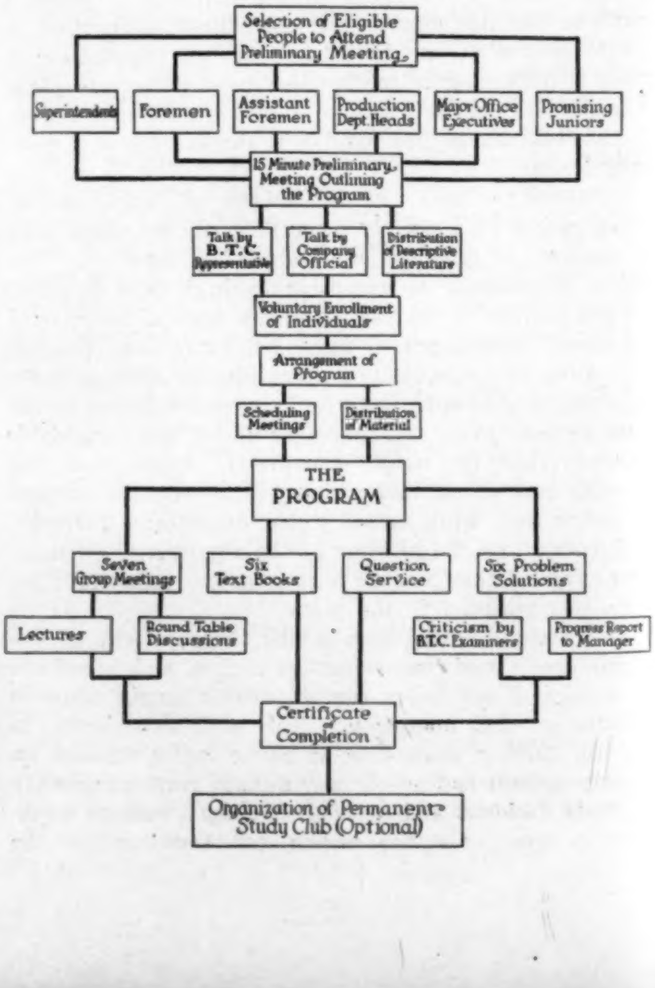
The proof that they benefit by the result of their study is found in the innumerable instances of improved work, better direction of a department, reduced friction in the handling of men, increased quality and quantity of output and other evidence that might be cited from the experience of plants where foreman training has been conducted. A few examples have been given at the beginning of this article, and many more are on record. Many companies have used the training as a foundation on which to build more specialized courses. Such courses have been found practical after the foremen have received the bedrock of basic production principles taught in the course and have been accustomed to study methods. In a number of instances, in fact, the men themselves have demanded some sort of continuation work; and this has usually taken the form of "Production Clubs" organized and manned by the foremen for the discussion of production problems, to keep abreast of production technique in the industry and to furnish a sort of foreman's council or cabinet for handling the questions that come up.

Thus a course in foreman training, if it is rightly conceived and conducted, becomes more than a temporary focusing of attention on production. It becomes the starting point and the foundation stone for continued work and for permanent improvement in the foremanship of the plant.

New York, N. Y.

Procedure in Foreman Training

Next in importance to the actual training of foremen is the method of procedure by which they are interested in and familiarized with the course of instruction. Manufacturers and executives who may have convinced themselves that foreman training is a good thing may still be in doubt as to the correct answer to the big question, "How shall the training be organized and conducted?" Those who have had experience in this sort of work have developed certain fundamental facts that apparently are requisite for success. The Business Training Corporation, for example, has charted its idea of the best procedure in the accompanying diagram which we reproduce from that organization's recent publication entitled "Twenty Thousand Better Foremen." The chart quickly visualizes the essential steps in organizing classes in foreman training.



The Design of Chemical Plants

Chemical Plants Generally Not Good Examples of Studied Design—Opportunity Is Good for Introducing Improvements From Analogous Industries—The Controlling Factors in Plant Design Should Be Efficiency in Material Handling and Allowance for Future Expansion

BY A. E. MARSHALL
Consulting Chemical Engineer

When a survey is made of operating costs in a chemical manufacturing plant, labor often bulks high, and while in high-priced commodities this may not cause inquiry or create a desire for investigation, yet in a low-priced article a high labor cost may mean not only a loss of profit but even a loss of business if demand is small and competition keen. Elsewhere in this issue various phases of cost and suggestions for lowering cost by increasing efficiency are discussed. This article is concerned with one important phase of operating cost—the handling of materials through the plant and the influence of plant design on the cost of pre-process and process labor.

Chemical Plants Not Examples of Good Design

Chemical plants as a whole are not striking examples of studied design arranged to obviate the use of labor in everything except its minimum essential form. The reasons for this vary—some plants have grown up around a small semi-commercial experiment, expanding as demand for the product arose; others, operating by rule of thumb, are equally rule of thumb on the engineering and design side. Still another reason lies in the fact that many plants operating today have not been changed in any essential detail for years, possibly since their original construction.

Most of the plants built during the war period were designed not for low-cost production, but by force of prevailing circumstances were arranged for the use of equipment which was available for delivery within a reasonable period.

There is, in the writer's opinion, room for considerable revision of engineering practice in chemical plants and for close study of the results obtained in other industries where the problems of manufacture are analogous to those presented in the chemical industry.

Material Handling a Controlling Factor

The need for efficiency in handling materials through the stages of chemical processes is more pronounced today than at any previous time in the history of chemical manufacture. Labor has not gone back to pre-war rates, and studies of the cost of living and correlated subjects indicate rather clearly that a return to pre-war figures cannot be counted on in any serious consideration of costs of operation.

The consumers of chemical products demand today standard grades at low prices, and the manufacturer who has consistently cut out surplus hand labor by the substitution of cheaper mechanical labor, who has re-routed movements of material, thereby shortening travel, is the manufacturer operating close to capacity and employing high total labor, but on a basis of low labor-hours per ton of product.

Conditions Governing Handling Equipment

In any consideration of mechanical handling there are certain fundamental conditions which must be met by the mechanical device. Interest on the capital expenditure involved, depreciation, repairs and labor cost for supervision must be less than the cost of the same operation carried out entirely by man power. This would seem to be a condition which would always receive first consideration, but examples could be cited from many plants to prove that a complete study of the cost of operating some mechanical device had not been made prior to its installation. Another essential is that the device must be capable of withstanding the unusual conditions of chemical plant service. A loading machine which handles sand will not necessarily have the same life when used on acid phosphate. It is not unusual to find that excessive corrosion, which is so often a feature of chemical plant work, makes it necessary before success is obtained to rebuild, with different materials, a machine which has given excellent results in some other industry.

Another important consideration is continuity of operation. Mechanical failure must be taken into account, and it often happens that too much trust in mechanisms, without provision of a safety bypass in the shape of a transfer of material by hand power, leads to a prolonged shutdown and to lessened output. In chemical manufacture, continuity of operation is generally much more important than in other industries. The volume and cost of output of a chemical process usually depend on the simultaneous carrying on of a number of stages of manufacture, and a shutdown of one stage adversely affects the other stages. This calls for close study not only of the desirability of being able to arrange temporary bypasses but also of the possibilities of failure in mechanical devices. Mechanisms adopted without change from other industries may give trouble, because the parts, while sufficiently strong to take care of materials of fairly uniform density, consistency, etc., are not strong enough to stand up under the variations of load and quality of load which result from some temporary disarrangement of a chemical process.

The question of plant design is so closely linked with the use of mechanical handling devices that beyond pointing out, as has already been done, some essential features of satisfactory mechanical equipment, the two subjects will be treated together.

Factors to Consider in Design of a New Plant

In considering the design of a new plant, the chemical engineer has several important factors to take into account. One which has received least attention in the past and one which has caused later on in the life of chemical plants either unnecessary cost of product or prevented possible reductions is the lack of provision for future expansion.

A successful plant necessarily meets with a demand for increased output, but unless the original design took care of the future need, the expansion either takes the form of a replica of the primary layout or the additions are crowded in wherever a vacant space is found.

In either case, lower costs are not likely to follow increased output.

If the design properly takes care of expansion, then certain parts of the plant mechanism can be worked at full load instead of being duplicated, and the same labor will perform more work. There should be greater economy in producing 50,000 tons of product in one plant than in turning out the same tonnage from two 25,000-ton plants or from a 25,000-ton plant which has been painfully stretched to give 50,000 tons.

Indefinite expansion cannot be provided for in design except by arranging for duplication, but doubling or even trebling the output can usually be taken care of by adding equipment in locations which were fixed by the layout of the original plant.

Other essential considerations are the receiving and storing of raw materials, the storage of finished products and the flow of materials from the raw to the finished product stage.

The Flow Sheet in Plant Design

In the metallurgical industries, a flow sheet is the starting point for consideration of any process or new plant. In the chemical industry it often happens that a flow sheet, when one is made, is worked up after the plant has been built and operations have been begun.

A large-scale flow sheet, showing daily tonnages moved at all points, and with maximum storage capacities for raw and finished products, should be the first step in designing a chemical plant.

Study of the flow sheet will bring out the salient features of the operation, and will suggest various arrangements of equipment and buildings which can be further studied by making experimental layouts in outline.

The flow sheet with its indicated tonnages and the outline layouts will show the points where handling of materials take place, and a decision can be reached as to whether a mechanical device or hand labor is desirable.

Possibilities of Equipment Developed for Other Industries

The chemical industry has been rather slow in the adoption of mechanical handling equipment, and even if there is no known parallel use of machinery for a certain purpose in chemical plants, it generally pays to make a survey of the use of equipment in other industries.

As an example, the use of bridge cranes may be mentioned.

Up to a few years ago bridge cranes were not employed in chemical plants, although in other industries they were enabling large savings to be made in the handling of materials.

Bridge Cranes for Handling

Today many chemical plants, particularly fertilizer factories, rely on bridge cranes for the movement of raw, intermediate and finished products, and by refinements in the design of the plants all the stages of production have been placed within range of the crane. A bridge crane represents a high initial investment, but it shows a good return when given sufficient tonnage to handle. As an example, a single bridge crane in a fertilizer factory can be utilized for all of the tonnage movements including:

Raw phosphate rock to storage.
Rock from storage to mills.
Acid phosphate from dens to storage.
Acid phosphate from storage to bulk shipping point or mixing department.

If the plant includes a mixing department the same crane can handle potash, ammoniates, tankage, etc., to and from the storage bins and mixing and screening machines.

Proper Arrangement of Departments

Careful planning of the operations cycle is necessary when a bridge crane is called on to serve various departments, otherwise the crane will waste time in travel with an empty bucket. Also the placing of departments demands study so that in a fertilizer plant raw phosphate rock does not have to be moved over the storage piles of acid phosphate. A leaking grab bucket, loaded with phosphate rock, which had to travel over stored acid phosphate might mean a serious loss through a portion of the rock finding its way into the official sample. Here again a study of a flow sheet, in plan, will obviate the need for changes after construction is completed.

Where a Monorail Should Be Used

While a bridge crane represents the maximum facility of tonnage movement, it frequently happens that the total weights to be handled do not justify either the installation or operating cost. In such cases it is often possible to incorporate a monorail crane system in the design, and to move materials by monorail grab cranes or tubs at much lower cost than a combination of conveyors, elevators and hand labor. The disadvantage of a monorail is its fixed position, which differentiates it from the free traverse of the bridge crane. A proper arrangement of plant units will, however, in most cases give the monorail system an opportunity to perform all the tonnage movements. It should be remembered that a monorail system is not really limited to the use of grab buckets. Movements of materials originating off the direct line of travel can be taken care of by a hook crane which picks up tubs transferred under the monorail by means of hand cars on a narrow gage track.

The inclusion of a weighbridge in the monorail track is often desirable, as it permits the weighing of furnace charges, etc., without the expense of double handling to and from a platform scale.

In the case of handling problems where there are two active lines of travel at right angles, it often proves advantageous to utilize two monorails at different levels. Transfers of material can be made by hook cranes and tubs or a transfer pit can be built for the use of grab cranes at the junction point.

Other Types of Handling Installation

Elevators and belt conveyors are familiar devices in chemical plant practice, and call for no special mention. Pan conveyors capable of handling hot or abrasive materials are now coming into use, and have already solved some problems which previously had been considered as capable of solution by hand labor only.

Each plant has of course some special handling problem which lies outside the general treatment of this article, so a tabulation is given of some of the labor-saving devices which have found application in such work in recent years.

Pneumatic conveyors of the air pressure or vacuum types.
Vacuum unloaders for ships and cars.
Storage battery trucks.
Skip hoists.
Mechanical car unloaders.
Narrow-gage electric and gasoline trolley systems.
Portable conveyors.
Box-car loaders for bulk products.

Providing for Raw Material Storage

One phase of plant design work which scarcely ever receives attention until the need presents itself is the provision of outdoor storage for raw materials which are not affected by the weather. Convenient covered or uncovered storage for such materials is of course an essential provision of the original design. At some time in the plant history raw materials accumulate in excess of the storage capacity, and as there is no opportunity for arranging adequate new storage, the materials are piled in the factory yard either by a locomotive crane or a portable conveyor. The provision of temporary trackage and the difficulty of making a clean-up are serious items in the cost of temporary outdoor storage.

If space for outdoor storage is provided alongside one of the permanent standard-gage tracks, a low-cost system of handling can be developed by the aid of a locomotive crane equipped with a grab bucket and mounted on caterpillar tracks. Such a crane has complete freedom of movement without the need for laying tracks and can recover a storage pile to the limit of grab bucket recovery without the use of a shovel gang. The locomotive crane with caterpillar tracks is also a valuable machine in other parts of the plant and has even been utilized in the case of a breakdown to replace an elevator.

The Plant Designer Must Investigate Other Industries

In conclusion, a statement is advanced that the chemical industry of today does not generally utilize to the best advantage mechanical devices for saving labor. The trend of prices makes it essential that the chemical engineer and the manufacturer study closely results which are being obtained in other industries with labor-saving devices. Some of these devices may need to be changed either in material or in the strength of parts before they are entirely suited to chemical plant usage —but the chemical engineer should be the one to investigate the possibilities, and to suggest to the equipment manufacturer the changes which are necessary to fit his machine to the needs of the chemical plant.

Baltimore, Md.

Increasing Heating Furnace Efficiency Through the Use of Insulation

Increased operating costs and keen competition have directed attention to many losses in the use of heat which were formerly disregarded. Prominent among these is the loss of heat through heat-treating furnace walls.

Design of Heating Furnaces

Furnace design and operation is probably the most inexact branch of engineering science. This is because results can be obtained that are satisfactory even if the methods are wasteful; and because it is extremely difficult to keep an accurate record of just what goes on inside the furnace walls.

Also, the prime consideration in the past has been to design the furnace to get the maximum production of high-class material; and methods of heating have only recently come to get the consideration which they must necessarily have in a period of high fuel costs.

At the present time, designers of heat-treating furnaces are fully awake to the necessity of constructing their furnaces so as to attain the greatest possible efficiency of operation. As a basis for this design it is necessary to find out where the heat goes and in what proportion.

Distribution of Heat

The heat generated in a heat-treating furnace goes in part to do the heating required and is in part lost through the walls and doors and up the stack. The heat required for the work and that lost up the stack are, in modern, well-designed furnaces, already kept at a minimum. It is to the reduction of losses through the walls and doors that we must look if we are to save heat through further improvements in design.

In the design and construction of heat-treating furnaces the conductivity of fireclay is of extreme importance. In oven furnaces, where a large volume of heat is required, particular attention must be paid to the conductivity of the firebrick employed, so that the thickness of wall may be determined to give the most economical working.

In the case of small furnaces which are used only during the day and require to be heated up to a working temperature each morning, the time required for this preliminary heating up will to a great extent depend upon the thickness and conductivity of the wall. In such cases the quantity of brickwork should be a minimum; 2½-in. brick backed up by 2½ in. of a good insulating material.

For large heat-treating furnaces which are working continuously the thickness of the wall should not be less than 13½ in.; a 9-in. course of firebrick, backed by a 4½-in. of insulating brick is good practice.

In general, in high-temperature wall construction, there are two separate and distinct factors which must be considered to produce an effective wall.

The first of these is to provide a material having the ability to resist the action of high temperatures, sufficient mechanical strength and, possibly, the property of resisting corrosive slags, gases, etc., without spalling or being eroded.

The second is to prevent the excessive loss of heat due to conduction from the interior of the wall to the outside, where it is lost by radiation or conduction.

It is rare that a good refractory material is an insulator; usually it is necessary to augment or back up the refractory with some material having a much lower heat-conducting capacity.

The following table gives a comparison of losses with insulated and uninsulated walls and various fuels which clearly shows how insulation increases efficiency:

FUEL LOSSES PER 1,000 SQ.FT. PER HOUR OF RADIATING SURFACE

Wall	Fuel	Loss per 1,000 Sq.Ft. per Hr. B.t.u.	Lb. Coal Loss per 1,000 Sq.Ft.	Gal. Oil Loss per 1,000 Sq.Ft.	Cu.Ft. Gas Loss per 1,000 Sq.Ft.	Calorific Value B.t.u.
Uninsulated	Coal	600,000	50.0	...	.....	12,000 per lb.
Insulated	Coal	220,000	18.3	...	.....	12,000 per lb.
Uninsulated	Oil	600,000	....	4.1	.....	145,000 per gal.
Insulated	Oil	220,000	....	1.5	.....	145,000 per gal.
Uninsulated	Gas	600,000	....	...	1,000	600 per cu.ft.
Insulated	Gas	220,000	....	...	366	600 per cu.ft.

Gas as a Source of Energy For Industrial Processes

Gaseous Fuel Not Only Gives the Highest Thermal Efficiency but Also Gives Opportunities for Increased Production Efficiency — Examples From Industry — Prospects for a More Extended Use of Gas as an Industrial Fuel

BY CARL J. WRIGHT
Technologist, Combustion Utilities Corporation

GAS, the ideal fuel, lends itself admirably to a program of increased efficiency in industry. When we think of efficiency in connection with a fuel we generally limit ourselves to thermal efficiency, or the ratio of heat output to heat input, but the subject may also be considered from the broader viewpoint of economy of natural resources and of human energy. As an industrial fuel it not only gives increased thermal efficiency, but in most cases gives increased quantity and better quality of product. It makes a clean workroom for the employees, and for this reason they are not only more contented but are healthier and can turn out better work.

Inasmuch as any fuel must be gasified before its heat energy is available, it seems logical that the fuel which is gaseous to begin with should be best adapted to give high efficiencies and close temperature control. Many industries today depend almost entirely on gas for their fuel requirements, and more and more industries are trying gas on operations heretofore carried on with some other form of fuel and are finding not only increased thermal efficiency but an increase in the quantity and quality of their product.

It should be understood that all gases are not equally efficient for all operations, but with the wide range of gases available for industrial uses it is possible to choose the kind of gas which has the proper characteristics for carrying on the heating operations in almost any industry.

EXAMPLES FROM INDUSTRY

The glass industry in the United States may be cited as an example of an industry which depends almost exclusively on gas as a fuel. In the early days of the industry it was thought that natural gas was essential for heating operations, and glass plants were built near each source of supply of natural gas as it was discovered. But as the natural gas fields became depleted and the demand for this gas as a domestic fuel increased it was necessary for many of the glass plants to look to some form of manufactured gas as a source of fuel. Today we find glass plants using various forms of producer gas, blue water gas, coke-oven gas, and in some cases the city gas which has been manufactured for domestic use. In all cases where they have given proper attention to furnace design and technical control of combustion they have increased the thermal efficiency of their operation and are turning out an improved product.

Several industries have found it highly advantageous to use gas as a source of heat energy in operations where temperature control and furnace atmosphere are important factors. For example, plants making porcelain enameled ware have found that they must have close control on both the furnace atmosphere and the temperature of the working chamber and they have found that gaseous fuels meet both of these requirements. For this operation the furnace atmosphere must be oxidizing and must have no carbon monoxide present; otherwise a smooth finish will not be obtained. For solid- or liquid-fired furnaces it is generally necessary to inclose the working chamber entirely so that the products of combustion cannot come in contact with the work. This results in very low thermal efficiency, because all the heat must be transferred through heavy refractory walls. Then too, the temperature within the muffle is not uniform, therefore a full load cannot be put in the muffle or some of the product will be second quality product. With gas, a semi-muffle or direct-fired furnace can be used. High thermal efficiencies are obtained and much more first quality material is turned out daily per furnace.

GAS AS FUEL IN THE METAL INDUSTRIES

Another operation in which the furnace atmosphere is very important is the melting of non-ferrous metals. Unless the atmosphere in the melting chamber is neutral, the metal losses will be high, and this metal loss must be charged to the fuel used. Gas and air can be mixed in very exact proportions, hence it is quite easy to control the furnace atmosphere with gas-fired furnaces so that a neutral atmosphere results. In fact, the kind of fuel used may affect all the subsequent foundry operations. In practice it has been found that metal melted in gas-fired furnaces will meet the strictest specification. At the same time these furnaces give good thermal efficiencies, low melting losses, high production per furnace and a clean, comfortable workroom. In crucible furnaces, longer crucible life is obtained with gas than with any other fuel.

The metal products industries offer numerous examples of the use of gas for heating operations, and in nearly every case the adoption of this form of fuel has resulted in higher thermal efficiency, better products and better working conditions. In annealing and heat-treating furnaces where gaseous fuels are used it is possible to have an absolutely uniform temperature throughout the whole working chamber, and this temperature can be automatically controlled; also it is possible to control the furnace atmosphere so that the material is not scaled. In heat-treating large guns gas has competed with electricity and oil, and it has shown a marked superiority in many cases.

Another use of gas in industry which is interesting and in which a superior product is obtained is in the carburizing of steel. In this case the gas is used as a carburizing agent as well as for fuel. The material to be treated is placed in a closed container and put in the furnace. A small stream of gas, rich in hydrocarbons, is admitted to the container. At this temperature the gas decomposes and the carbon is readily absorbed by the steel. The residual gas is returned to

the furnace burners and makes up part of the required fuel for the operation. Thus it is seen that the use of city gas for this purpose eliminates the use of compounds, packing, metal boxes and considerable labor. The parts to be treated come up to temperature uniformly and an excellent "case" is obtained. Another thing possible with gas and not with solid carburizing compounds is the production of a diffused "case" which is obtained by turning the carburizing circuit of gas off several hours before removing the material from the furnace. By this method an excellent "case" which blends with the core is obtained.

Some Other Economies Resulting From Use of Gas as Fuel

Many engineers believe that the day is not far distant when the majority of all heating operations will be carried on by gaseous fuel, even to the extent of using gas for firing boilers. And we may even see the time when gas will be a source of power for industry through the medium of improved internal combustion engines. This is already done in those industries which produce gas as a byproduct, notably the steel industry; for in such cases the gas would be largely wasted if it were not so used and so its use even with inefficient engines is clear gain.

If gas is adopted as a universal source of fuel energy, there are a large number of factors which will effect economies of both natural resources and human energy. If the atmosphere surrounding our cities and industrial centers were free from smoke, as it would be if gas were used for fuel, much less artificial light would have to be used. This not only gives a direct saving in the cost of lighting but the workmen are able to produce more and better work. Another economy which would be apparent is the saving in cost of cleaning and redecorating our buildings. This cost is due almost entirely to the smoke and soot which is thrown into the atmosphere during the combustion of solid and liquid fuels. If no solid or liquid fuels were burned in our cities, we would notice enormous savings in laundry bills and savings in cost of wearing apparel due to the fact that our clothes would not have to be washed so frequently or so vigorously. In addition, the burden of the housewife in keeping her house clean would be materially reduced.

Another item which should not be overlooked is that, in the burning of raw coal, most of the valuable condensible products—particularly tar and ammonia—are lost. A portion of these products is burned and some heat energy is obtained, but these products would be many times more valuable for other purposes than they are for fuel. Far-seeing fuel engineers are of the opinion that it will not be many years before industries in the United States will be compelled, not only by economic laws but also by federal legislation, so to process their raw coal that all these valuable byproducts will be recovered. Some are even advocating the conversion of all coal into gas and condensible products at the mine and transporting the gas to the cities and industrial centers through high-pressure pipe lines, to take care of the entire heating requirements of the community. Whatever may come of these larger visions, there still remains immediately at hand the direct advantage in production efficiency from wider use of gaseous fuels as the source of energy for industrial processes.

New York, N. Y.

Building the Plant Around the Transportation System

Production has in the past been generally considered as largely a matter of management. Today, in most chemical plants, the speed and efficiency at which men work is a matter of human control; and the efficiency of the plant is therefore a variable quantity—one impossible to forecast—and the difficulties of successful operation are manifold.

That this condition need not always maintain is the discovery of the last few years, particularly in the field of metal working. What is successful there can be applied at least in part in chemical industry. To illustrate what is meant, we quote the following from the August, 1922, issue of *Industrial Management* on the subject of the Ford plant at River Rouge:

Solving the Management Problem

"Even the major problems of management, strange as it may seem, have been solved at this plant by machinery and engineering. The 22,000 workers at River Rouge require an astonishingly small amount of supervision. Clerical and administrative labor has been reduced to an almost unbelievable minimum. Routing and dispatching are handled as engineering rather than as management problems; and solved by machinery, through transportation, rather than by management through supervision. Stock-keeping presents no unsolved problems, because the various processes, from the ore pile to the finished tractor on its freight car, have been mechanically timed to such a degree that production is a continuous flow without the need of stock reserves.

"Management difficulties that force themselves to the foreground at the average plant are non-existent or at least invisible at River Rouge. Ford and his engineers have made sure that the big basic principles are right and stay right so that details that would otherwise annoy and perplex seem to arrange themselves without obvious effort.

A Complete Industrial Chain

"Aside from all this, the River Rouge plant is of absorbing interest as a unique example of a substantially complete industrial economic chain. Ore from the Ford iron mines hauled on Ford's railroad is converted into pig at the Ford blast furnace and made into castings at the Ford foundry. Coke for foundry and blast-furnace use is produced at the Ford coke ovens. Gas for steam-electric power production, ammonia, distillates, tar and illuminating gas are produced at the Ford byproduct house and gas house. All of these units in the industrial chain are geared up as one complete machine.

The Conveying Equipment Is the Heart of the Organization

"Mechanical transportation forms the links which unite these separate units and their parts into one smooth-working, continuous process. Starting with the cranes which unload the raw materials, through the interplant conveyors that feed product parts, fuel and supplies in continuous, co-ordinated streams, everything is kept moving—by machinery. The spirit of the plant impresses the observer as an allegorical picture—a picture of engineering genius wrestling with time, for the prize of accomplishment."

Relation of Health and Happiness of Employees To Production in Industry

By John S. Shaw
Hercules Powder Company

In This Article the Author Has Tried to Bring Out the Important Fact That Industrial Managers Should Give as Much Time and Study to Human Problems as They Give to Physical and Technical Problems of Production

HEALTH: "A condition of soundness of any living organism, that state in which all the natural functions are performed freely, without pain or disease; freedom from sickness or decay."

HAPPINESS: "The pleasurable experience that springs from possession of good, the gratification of noble desires; the relief from pain or evil; enjoyment."

These definitions cover two human conditions which concern us very deeply. Much has been said and done to demonstrate the direct relation existing between man's health and happiness and his efficiency. During the years following the Civil War, and up to the present, the race for industrial supremacy has been keen and competition has extended around the globe. Leaders have toiled through a maze of factory problems, primarily leading to greater production, satisfactory quality and lower costs.

When considering these problems they naturally have concentrated on various processes, both mechanical and chemical, and on machinery or equipment in their plants. At the same time they have paid too little attention to the human side of the problem, taking for granted, more or less, that as long as men are paid the prevailing wages of their neighborhoods or calling, they should be thoroughly content to toil day after day, with no other inducement than that of earning their livelihood.

No doubt we all have experienced the fatigue due to monotony, which is a far more serious condition to humans than the mere physical or muscular fatigue. This may be explained by pointing out certain men whom we have known whose earnings are well above their standards of living, but at the same time those men are not contented, even granting that they may be healthy. Many such men do not know the cause of their discontent. They know that they are not satisfied. They will admit that they are restless, and they will seek higher wages, believing that the cause of dissatisfaction is insufficient money compensation.

In general we workers base our needs upon daily occurrences and environment, and fail to think out a clear and possible means of arriving at the greatest common good to all. The worker constantly wonders, "How much pay can I get for the least possible work?" while the employer is thinking, "How much production can I get for the wages I pay?" and the public criticises both and complains of the high cost of living.

What Is Needed to Insure Health and Happiness?

What is needed to insure health and happiness of our employees and a stronger and safer development of industry? Is it a method, preventive measure, or a cure?

Management really has two sides which should be equally developed and balanced—one the administration of production, the other the administration of those who toil and actually produce with their brains and hands. There should be no line drawn between the two, but they should be in separate departments and each equally a half of the administrative whole.

Production and costs depend absolutely upon human efficiency and, as human efficiency depends upon the health and happiness of all of us, it is obvious that any action tending to promote health and happiness will directly affect production and costs and greatly benefit society.

Health

Before undertaking any great and important work, the worker should be in good health. He should have complete control of all his physical faculties with the slightest amount of effort. His environment must embrace clean living, sufficient nourishment, good housing and pleasant surroundings, in order that his body may be "in that state in which all the natural functions are performed freely, without pain or disease." Health is the foundation of happiness, for we all know how little enjoyment there is in life to the physical sufferer. The employer should see that his workers are enjoying proper living conditions. He may have direct influence over this through the control of "company houses"; if not, he will have to make an effort to persuade and influence his workers to create proper homes from their earnings. A good manager will go as far as assisting the employees to move to desirable and better homes.

Medical and Hospital Service

If the organization is sufficiently large to warrant a company doctor and hospital, they should be employed. It is strange to note that there are still many employers today who doubt the benefits derived from medical and hospital service to their employees. They believe that this is a delicate matter and is more or less trespassing upon the privacy of the employee to seem to thrust such service upon him. In answer to this, I can say only that there are many instances where we owe it to the employees as well as the stockholders to see that our employees are protected from the spread of disease among their fellows.

Some employers also believe that the only purpose of medical service is to avoid the employment of the physically unfit who may make the unjust claim that an injury or disease occurred after employment. The matter of medical service is, therefore, regarded in the light of a gamble by some employers, who depend upon observations of their foremen to detect physical weakness or disease. Unfortunately this belief may result in very serious injury to both employer and employee. The latter may unknowingly undertake work for which he is unfit and, in consequence, become ill or injured to the extent of loss to himself and employer; to the employee through decreased earnings and suffering to himself and family and to the employer through risk of health and safety of his organization and lowered efficiency and increased labor turnover. Health is the greatest capital man has. Without it the best of brains may fail.

For those organizations which are too small to afford medical and hospital service to the employees, I would

suggest the employment of a physician for a certain hour or two of each workday, during which time employees requiring medical service may call upon the doctor and receive the benefit of his care and advice.

SAFETY

A good live program of safety should be carried out. Fire and accident prevention are not only humane undertakings, but are of great economic importance. Most employers have found this to be true, and it is gratifying to see the great progress that safety work has made. There is another real reason for safety work—namely, the psychological effect upon the help. Instead of fear of death and injury, the worker's confidence is increased and hence the contribution to his happiness. The most successful safety work is noticed in factories where the help are all given an equal chance to make suggestions to a committee appointed by themselves and guided by wise management.

Happiness

CREATIVE IMPULSE

Isn't it surprising how many schemes and methods are in practice today under the name of scientific management? We have anything from employees' representation to profit sharing. The magazines and books are full of such ideas, but very few speak of the key to the worker's real happiness—viz., the instinct of workmanship, or the creative impulse. The desire to be creative is fundamental in human nature and failure to find an outlet for self-expression results in serious difficulties. Suppression of this basic natural tendency is potentially disastrous. The task of the management should really be to find some positive and constructive outlet.

A few men in our country have practically spent their lives endeavoring to solve the problems from the human side, and since the great war the mysterious "personnel department" has sprung into greater prominence. Tead and Metcalf describe personnel administration as "directing and co-ordinating human relations of any organization, with a view to getting the maximum necessary production with a minimum of effort and friction and with proper regard for the genuine well being of the workers." Notice there is not in this definition a single word mentioning costs! In their splendid book entitled "Personnel Administration" they cover the subject in a remarkable and interesting way.

R. B. Wolf, industrial engineer, of New York City, has spent the last 20 years seeking out the healthful and happy way for workers to pursue their labors. Today he is one of the foremost managers and authors connected with industry, and while he is thoroughly practical and realizes the importance of low costs, the main theme of his work is "non-financial incentives" and the appeal to the creative impulse of man. So important does Alfred Korzybski consider the freedom of this expression that he attributes not only restlessness of the individual but wars of nations to the suppression of the creative impulse, or the "instinct of workmanship."

First of all, man seeks work because he must be clothed, fed and housed. He goes to work and is given what appears to be a fair wage. He may set a pace to the machine he operates, or that contrivance may be a pace setter to him. He does the same thing over and over every day in the same way and draws his pay from week to week with the same dumb monotony. He sees others enjoying more comforts than himself and he strives for those pleasures, comforts and perhaps luxuries, or, better still, he desires to possess his own home where the love of a wife and children control the center of his ambitions.

At this point, if his employer takes an interest in him, gives him a little encouragement and explains the why and wherefore of his job and the nature of the service rendered to the public through his labors, there is not much danger ahead. If he is permitted the full exercise of the creative impulse, given proper guidance and credit for his fruitful efforts, he is bound to be content. In order to accomplish this, a proper system of records and charts should be kept before the workers. Every one likes to watch a scoreboard, no matter what the game. Friendly competition is a stimulant to man's incentive. Here's where the love of creation comes in. After all isn't it something divine in man? His love of accomplishment and desire for approval are real forms of human expression. This desire is often obscured by more immediate claims and sometimes little appreciated because of the paralyzing effects of fear.

The problem, then, is to permit men working in groups to retain their individuality and for each man to feel that he is an independent human being, striving toward a definite goal to be attained only by his individual effort. To make him see that co-operation with fellow employees and his employer is the best means of attaining true individuality and self-assertion is difficult, but this can be accomplished by the principles involved. It is obvious that as the understanding of individual obligation spreads so as to include groups, a tremendous source of human energy and power which is now little understood will be made available to society.

RELIGION

Good "old-fashioned religion" is not to be considered too lightly. Co-operation with the religious teachers means fellowship, co-operation and an honest striving of the masses for service and common good. If a man is suppressed in or discouraged from progressing along proper lines, immediately there is trouble ahead. Selfishness and jealousy kindle and trouble brews from worker to worker, while the thoughtless manager schemes on his production and costs.

What then is meant by "proper guidance"? For instance, right now we believe that we are facing a long period of deflation. Wage cuts are in vogue and if history is to repeat itself labor will be sullen for some time to come. As the value of the dollar rises, the amount of money earned must necessarily become less and less. Such a condition should be frankly and sincerely explained and discussed with the men.

REPRESENTATION OF EMPLOYEES AND PERSONAL CONTACT

In small organizations I suppose it has been recognized since before the day of Moses that personal, friendly contact with the toilers is the greatest salvation to enterprise. There is little trouble in factories or shops where the boss knows all the men and they have confidence in him. In larger organizations, say over 500 employees, where the boss is too busy to keep up his acquaintance with every one of his workers, and while he is engaged in his problems which keep him in his office a great deal of his time, there is a tendency for the value of contact to be forgotten and the kind and sympathetic policy of even the greatest hearted leaders fades out before it reaches far down the line in the organization.

If this condition exists, it would seem that a proper time should be set aside for the meeting of representatives of the employees, at which time the management will give their full time and attention to the desires and suggestions of the workers. All men can reason and most men are honest. If a request or suggestion be not granted the workers, they should be thoroughly satisfied with the reason and mutual agreement enjoyed by both sides. A great deal of time has been spent as a result of plant managers attempting to give employees what they think they should have instead of finding out in an open meeting—through free expression of employees—what they really want. It requires sincerity and frankness to point the way, so that men may enjoy freedom of expression, proper guidance and square treatment.

Progress

We all know what it is to feel the joy of progress. But because of the competitive state of industry, there is a limit to wages that may be paid. Consequently we should not relax in our effort to keep up interest among the workers by training them more and more in their work, promoting them when we can and, when we find our organization too small, going to the extent of helping them get larger positions with other employers. The incentive given the workers in any organization through this policy is great and more than compensates for the loss of a valuable employee occasionally. Then every worker will feel that if he reaches his limit in the organization he is still preparing himself for a greater reward elsewhere, and that the boss will be glad to say a good word for him, and in fact help him to obtain a better job.

Recreation

Pleasure during leisure hours is very important, and a little effort on the employer's part to put system into leisure is a very valuable thing. When the tension of work has ceased at the end of the day, the worker is naturally restless but happily in a receptive mood where pleasure is concerned, and at this moment we should endeavor to meet him and fulfill his want and give him legitimate opportunities for wholesome pastime. This may be accomplished by seeking out a few well-known and trusted employees and asking them to form a committee which will nominate officers among the help, in an open meeting, to serve on a recreational board. When this board is elected by the employees, it should be understood by all that the management shall at all times maintain the power of veto whenever it is found necessary to use it, or to maintain order and to prevent unreasonable expense. There are many forms of entertainment which by the aid of both men and women of the plant are readily worked out.

Pride of Possession

History seems to indicate that those people who own their homes or possess land are the least apt to rebel against their governments. We know that the man who is interested in his home is happy, and I believe the time is coming when industrial workers will be encouraged more and more to own their homes. It is certainly a stabilizer, for men will stop to reason when something they hold dear is at stake. Employers are realizing this and are assisting their help in purchasing their homes or by fostering some sort of thrift plan which leads to saving and financial independence.

So far we have considered the matter of honest, sympathetic and wise management of the worker and his health and happiness during work and recreation, but there is still another great power to reckon with for the building up of happier relations and a sympathetic understanding between worker and manager, and that is the pride of ownership in the enterprise.

Thrift Plans

Stock subscriptions on easy term payment plans and in proper proportion to the worker's wages have improved workers and employers alike. It is a foolish man who tears down that which he builds himself, and dividends paid to stockholding employees have a marked effect in establishing contentment and understanding. We shall hear less about "capital and labor" when more of us who labor are "capitalists" too. The worker who owns stock in his company soon learns that without capital there is no labor or vice versa; that each is an equal half of the whole, that one cannot exist without the other.

The world is getting better. Men are thinking more of the general welfare of the race than ever before. There is more real honest effort to be frank and honest with each other, and, in spite of the present turmoil and severe loss of time and production due to strikes and their causes, men are drawing nearer the solution. Selfishness is slowly but steadily giving way to justice, and it will not be many years before unjust demands will be met by such strong public disapproval that men will strive harder and more unselfishly to co-operate. No profit will be considered worthy or gratifying unless it is earned through fair service to investor, toiler and the public alike. Progressive business men are accepting the belief that this is good business.

There are still too many fault finders instead of fact finders. We should remember that the procedure is, after all, a simple one based upon justice, common sense, perseverance and an abundance of patience.

Wilmington, Del.

Safety Organizations as an Aid to Health and Happiness of Employees

Harry A. Schultz, assistant manager of the bureau of safety, sanitation and welfare, U. S. Steel Corporation, has published an article in *Safety* for August in which he describes some of the functions of the safety organization. One thing stands out in the article. It is the tremendous aid which a safety campaign can be toward furthering the health and happiness of the employees, not only the actual diminution of injury and consequent gain to the organization but the mental relief which comes to the worker when he realizes that an honest, intelligent effort is being made to protect his interests and his health. Workers are quick to see through subterfuge. They realize immediately when an attitude is sincere and when it is camouflage.

Another point which Mr. Schultz mentions has to do with stimulation of the safety spirit. An obviously guarded machine is a distinct asset to shop morale.

Educational activity in connection with safety campaigns is another phase of work which must be very carefully tuned to workers' psychology. Straightforward honest substance must be the backbone. A splendid example of failure in such a campaign was an Americanization campaign carried out in many industrial plants and an equally splendid example of success is the safety poster campaign which runs continuously as a service.

Standardization Will Increase the Production Efficiency of the Chemical Industries

THE industrial significance of standardization has been ably defined by Dr. P. G. Agnew, secretary of the American Engineering Standards Committee, in a platform of sixteen points, seven of which pertain directly to increased production efficiency. These seven points are as follows:

Standardization stabilizes production and employment.

Standardization makes mass production possible.

Standardization eliminates indecision in production.

By concentrating on fewer lines, standardization enables the manufacturer to put more thought and energy into designs.

By bringing out new facts in order to determine what is best and to obtain agreement on most questions, standardization acts as a powerful stimulus to research and development.

Standardization is one of the principal means of getting the results of research and development into actual use in the industries.

Standardization helps to eliminate practices which are merely the result of accident or tradition and which impede development.

These are some of the things that standardization will do for industry in general, and there is no real reason why it will not do as much for the chemical industries.

Present Status of Standardization in Chemical Industry

To judge from the experience of other industries, such as those in the electrical and automobile fields, it would seem probable that standardization will proceed slowly in the chemical industries during the next few years, after which it will go forward on an increasing scale and with increasing rapidity. There is no doubt that if standards are agreed on properly by producers and consumers, they will come into as general use and be of as great advantage in the chemical field as elsewhere.

A great deal of valuable standardization work has already been accomplished in many of the chemical industries. Consider a few examples: In the fertilizer field there has been extensive work done in the standardization of grades. This has been worked out by cooperation between producer and consumer. In the paint and varnish field a great deal has been done in defining materials and in agreement on methods of test. Cement is in excellent shape; better, in fact, than most other industries. This results from the fact that the American Society for Testing Materials and the various governmental bodies concerned finally settled on specifications. These are now universally recognized as a real national standard. In rubber comparatively little has been done.

Standardization Work by Technical Societies

The American Chemical Society has had, for many years, a supervisory committee on methods of analysis which has done work of far-reaching consequence. The work of this committee has been of considerable help to other societies engaged in standardization.

A well-known example is the valuable contribution of the Manufacturing Chemists' Association to the movement through the standardization of the Baumé table for determining the specific gravity of liquids. It was not so long ago that there were in use in America twenty-three different variations of the Baumé scale. The result, of course, was infinite confusion. Today there is one Baumé scale in use throughout the United States; a fine example of increasing production efficiency through standardization.

Need for International Standardization

The Baumé scale used in America, however, is not the Baumé scale used in Germany. This brings us to the need for international standardization. In America 66 deg. Bé. indicates 93.5 per cent sulphuric acid; in Germany 66 Bé. indicates 98 per cent sulphuric acid. There are cases where 98 per cent is effective and 93.5 per cent no better than water. Yet there are in America hundreds of students and others reading German literature on the subject, conducting experiments and carrying on research without realizing this difference in the Baumé scales of the two countries. In England there is still another scale, called "Twaddell" after the man who devised it, but it is not used in America.

Standardization of Nomenclature

If we are to increase our production efficiency, we must first of all learn to talk the same language. In other words, a prerequisite to increased production efficiency in the chemical and metallurgical industries is, as in other fields, the standardization of nomenclature. If we are to have increased production efficiency, we must first settle on definitions. Sulphuric acid, for instance, should always be designated in terms of SO_3, sulphuric anhydride, which is common to all strengths of acids. In one large American company all sulphuric acid accounts are kept in terms of SO_3, and as a result this company knows immediately the cost of any strength it needs. It is difficult to understand how the manufacturer who does not keep his sulphuric acid accounts on this basis can know what he is about in handling sulphuric acids. Yet there are few manufacturers in America who observe one standard in their records.

Standardization of Equipment

There is a tremendous opportunity in the chemical and metallurgical industries for the standardization of apparatus, tools and other mechanical equipment. In this work the chemically controlled industry appears as the ultimate consumer, instead of as a producer, its rôle in the case of materials.

Work of the A.E.S.C.

The standardization that has already been effected has been possible only because the producers, consumers and general interests were brought together. The necessity of this has been shown over and over again in the experience of those bodies which have done extensive standardization work. It often happens that before agreements can be reached the air has to be cleared of misunderstandings through disagreements and controversies, not to say fights, that have sometimes lasted for

years. Yet when these differences have been thoroughly threshed out, results of great value are almost sure to ensue. The development of the whole co-operative idea in industry has brought about the possibility of systematic co-operation in standardization work on the part of the various bodies which speak for industry, and the American Engineering Standards Committee has been developed as the mechanism of this systematic co-operation. Conversely, the very existence of the A.E.S.C. has stimulated industrial co-operation in standardization by those interested.

Standards Now Being Considered

Many of the men who are most active in the affairs of the A.E.S.C. are identified with the chemical industries or the profession, and at least fifteen of the eighty projects now under consideration are of direct interest to the chemical and metallurgical industries. This list includes the following:

- Chemical analysis of alloys of lead, tin, antimony and copper.
- Electrical properties of aluminum.
- Standard methods of laboratory sampling and analysis of coke.
- Safety code for explosives.
- Specifications for galvanizing and sherardizing iron and steel.
- Gas safety code.
- Standard specifications for purity of linseed oil from North American seed.
- Paper and pulp mills safety code.
- Standard method of test for penetration of bituminous materials.
- Pipe flanges and fittings.
- Color schemes for pipe lines.
- Safety code for tanneries.
- Safety code on ventilation.
- Zinc and zinc ores.

Standards Already Adopted

Nine standards of a chemical nature have already been approved:

- Specifications and tests for portland cement.
- Standard method for distillation of bituminous materials suitable for road treatment.
- Standard method for sampling of coal.
- Specifications for lake copper wire bars, cakes, slabs, billets, ingots and ingot bars.
- Specifications for electrolytic copper wire bars, cakes, slabs, billets, ingots and ingot bars.
- Methods for battery assay of copper.
- Methods of chemical analysis of manganese bronze.
- Methods of chemical analysis of gun metal.
- Specifications for the testing and use of permissible explosives.

What Standardization Will Do For Industry

Standardization is merely getting together and agreeing. Among the important things which standardization will do for the chemically controlled industries are:

It will provide a more truly competitive market in which to buy equipment.

It will make it easier to repair and replace chemical manufacturing equipment.

It will reduce the cost of manufacture.

It will simplify the keeping of cost accounts.

It will eliminate most of the controversies as to whether the product is in accord with the sample.

It will increase the production efficiency of the industry.

It will give accurate definitions to enable one to know what he is talking about, what he is buying and whether he is getting what he is buying. Such definitions will go far to eliminate disputes and litigation.

Standardization of Shipping Containers

One of the most important phases of the standardization campaign is that which looks toward the adoption of standard, efficient and simple containers for shipping purposes.

At the recent meeting of the American Society for Testing Materials a committee report was presented on this subject which shows the progress which has been realized in the campaign for such containers.

Work by the A.R.A.

The importance of determining what shipping containers are proper and efficient and of prescribing clear and definite specifications for them has been recently recognized in a very active manner by the American Railway Association. The executive committee of that association, in connection with its drive to reduce loss and damage, has ordered the bureau of explosives to expand its test and specification department to include the investigation of shipping containers for all kinds of commodities and to prepare recommendations in the form of specifications for the efficient container.

The freight container bureau is investigating shipping containers from a purely engineering standpoint, which will, of course, involve special consideration of proper economies and the standardization of types as well as the actual efficiency of construction for transportation purposes. Investigations are being made at plants making the containers and at plants using them; shipments are also to be followed and observed at railway stations and steamship piers to determine actual results in transit.

Reasons for Container Standardization Found Within the Plant

In addition to the economies and advantages to be realized in rail and water shipments through the adoption of simple and standard containers, the use of these containers aids greatly in the efficient operation of the manufacturing plant itself.

Containers must be either purchased or made in the plant, and, in either case, the fewer the types used and the more nearly uniform these types are, the less space is required for their storage. If the containers are made in the plant, then the parts or the material from which they are made will be received in an unworked state. In this case, the labor cost of working this material up into the desired form is reduced in proportions as the number of styles and sizes of containers is reduced.

The Standard Container and Automatic Equipment

To realize, in any industry, the maximum efficiency of production, we must resort to the fullest possible extent to the use of automatic and labor-saving equipment. This applies possibly more to packing and shipping the product than to any other operations which it undergoes. It will be readily recognized that wrapping and filling equipment can be applied to only a limited range of container sizes. So also, conveying equipment is limited as to the types of container which can be handled. Thus unless a plant is to have a multiplicity of this automatic equipment, much of it idle at any given time, or is to do without realizing the full advantages of this equipment, it becomes necessary to confine the containers used to the smallest number of simple types which ingenuity can devise.

Manufactured Weather And Personal Efficiency

An Analysis of the Advantages Which Accrue From the Use of Humidified Air-Ventilating Systems — Especially With Reference to the Efficiency of the Individual Worker

BY WILLIS H. CARRIER
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IN MANY industries the modern science of air conditioning is employed effectively to increase the process efficiency where products sensitive to atmospheric temperature and moisture are involved. The idea of manufacturing weather to meet the requirements of the many industries manufacturing such products is already firmly implanted in the minds of the great manufacturers of this country. In fact, manufactured weather, made to meet the exact requirements of these industries, has so improved their process efficiency that the manufacture of such products as cotton, wool, silk and other textiles, tobacco, candy and bakery products may be said, without exaggeration, to have been revolutionized by the application of scientific air conditioning.

It seems, therefore, quite astonishing that a conception of personal efficiency, as affected by the physical condition of the worker, has not developed coincidentally with our intense development of process efficiency. It is true that in the modern plant the physical comfort of the employees is most carefully considered with respect to sanitation, seating, lighting and arrangement of equipment to minimize the effort necessary to the given operation. But in only a few of our modern plants have the effects of the condition of the surrounding atmosphere been considered.

ELEMENTS OF PRODUCTION COST

There are three elements of production recognized as determining the profits of a manufacturing process:

1. The volume and value of the product produced for a given plant investment.
2. The quality and uniformity of the product produced.
3. The cost for labor per unit of production.

Even in cases where the product is of such nature that the first two of these factors are not involved, the third factor is so directly affected by the atmospheric conditions within the plant—that is, temperature, humidity and cleanliness of the air—that scientific air conditioning will prove an exceptionally profitable investment. Although it is true that in a surprisingly large number of industries the product itself or the process of its manufacture is directly affected by atmospheric conditions so that upon the basis of enhancement of process efficiency alone air conditioning pays handsome returns, it is the province of this paper to discuss primarily the effects of air conditions upon the human being as these effects are related to the personal efficiency of the worker.

No matter how highly mechanized the given industry may be, the quantity and quality of the product always depends, in large measure, upon the personal efficiency of the workers themselves. It is a well-recognized fact that the personal efficiency of the human being is seriously impaired when he or she is subjected to improper air conditions, such as excessive heat or cold, excessive humidity or dryness, or air that is contaminated with dust, fumes or other injurious impurities. Unhealthful and depressing air conditions are inherent in the manufacture of certain products, such as the excessive heat caused by the power utilized in a large textile mill, the fumes in a chemical plant and the dust in a tobacco factory.

In most of these industries the condition is so acute that it has received the attention of employers by force of necessity. In many other industries where the condition is of lesser degree, the impairment of personal efficiency is scarcely the less serious and the question of providing healthful and invigorating air conditions is of great importance.

CONDITIONED FACTORIES CAPABLE OF HOLDING WORKERS

There are, in fact, many instances where the personal efficiency of the workers themselves has proved of greater moment than the mere mechanical efficiency of the process. In any industrial community where there is broad opportunity of choice in employment, workers will seek employment where conditions in respect to health and comfort are most satisfactory, assuming that wages are approximately equal. This is particularly true of female workers, a great many of whom are willing to accept work where the factory conditions are good and the environment proper, but who would not work, unless compelled, under unhealthful or distasteful conditions.

Thus one of the first direct results of improving the atmospheric conditions within any manufacturing plant is the attraction of a labor supply which is satisfactory in both quantity and quality, permitting the selection of more efficient workers at a reasonable wage. In addition there is a correspondingly lower labor turnover because the employees are satisfied and anxious to retain their positions in the plant where healthful and invigorating conditions are assured by the installation of well-engineered air-conditioning equipment, the labor problem is greatly simplified and it is possible to develop a carefully selected personnel, so that the common dissatisfactions are practically eliminated, the turnover is minimized and there is little necessity for discharge and replacement.

Analysis of labor cost by Mr. Alexander of the General Electric Co. has shown that the cost of losing one worker and replacing him with another amounts, both directly and indirectly, to from $50 to $250, depending upon the skill and experience involved. A low labor turnover and satisfied employees are, therefore, exceedingly important elements in the cost of production. Before discussing the importance of proper air conditions, let us examine the factors which are involved and the conditions conducive to health and vigor, or, in other words, to personal efficiency.

The problem of the air-conditioning engineer is divided into two distinct phases—that is, conditioning in the winter and in the summer. In winter there are

two principal factors: the uniform heating of the inclosed space to a definite controlled temperature, and the addition of sufficient moisture to supply the deficiency in outdoor winter air which has been heated to ordinary indoor temperatures. For example, outdoor air at zero, assuming it to be fully saturated, will contain less than one-half of 1 grain of moisture per cubic foot. This air when heated to 70 deg. requires, to saturate it, 8 grains of water vapor per cubic foot. Thus the relative humidity of zero outdoor air heated to 70 deg. indoors by any of the common methods of heating, such as the steam or hot water radiator, which do not add appreciable quantities of vapor to the air, would be approximately 6¼ per cent, since the air would contain but one-sixteenth of the moisture which it could contain at its new temperature. Thus such air would be so excessively dry that it would exert an intense drying effect upon the skin and the delicate mucus membranes of the noses and throats of the workers. Such a condition inevitably produces a severe physical depression in the worker and an accompanying mental depression which are reflected in a dullness which in turn seriously impairs the personal efficiency of the worker from the production standpoint. Further, such a condition is conducive to colds, bronchitis and similar ailments which cause a high rate of absenteeism and a consequent decrease in production, together with an increase in production cost.

A suitable air-conditioning equipment will relieve such conditions of excessive dryness in closed buildings, under winter conditions, by automatically humidifying the air to that percentage of relative humidity most conducive to health and vigor. In addition, such equipment will afford a distribution of the conditioned air so uniform and so free from drafts that the general comfort and health of the worker will be enhanced.

Summer Ventilation

In the summer the problem is reversed. The presence of a large number of workers within an inclosed space, in conjunction with heat generated by power, lights and other causes, even if all of the ordinary means of natural ventilation, such as open doors and windows, are employed, will cause a vitiation of the atmosphere and an increase in temperature which will result in depression, dullness and loss of personal efficiency. It is well known that in many industries production, during the extreme heat of summer, will fall off as much as 25 per cent.

Dr. E. Vernon Hill of Chicago has made experiments indicating that the cooling effect or comfort condition of the air depends in a larger measure upon the wet bulb temperature than upon the dry bulb temperature. He found that the most comfortable wet bulb temperature under normal conditions is about 56 deg., although this point must be raised in summer time in order not to cause too great a contrast between outdoor and indoor conditions. He also determined approximately the relative effect of air velocity in producing a cooling effect. For example, we have all noticed the cooling effect of a draft of air or of an electric fan even though there was no actual change in temperature or moisture condition. This occurs because the air under velocity is capable of carrying away a greater amount of heat. Dr. Hill has related the wet bulb temperature and velocity conditions in so-called zones of comfort so that, with a given wet bulb temperature, the velocity required to insure comfort and health can be readily determined.

There are two methods by which the summer conditions can be relieved. In a building where there is a great inherent heat source, such as a textile mill where a great quantity of power is utilized, evaporative cooling may be employed. In this method all of the air enters the building through a humidifier which cools it to the outdoor wet bulb temperature* (usually from 10 to 25 deg. below the dry bulb temperature) and fully saturates it with water vapor, at the same time washing it clean and free from dust and other impurities.

The conditioned air, saturated at the outdoor wet bulb temperature, is then uniformly distributed throughout the building in such volume that the rise in temperature within the room is sufficient to depress the relative humidity to a comfortable degree, though the final temperature is an appreciable number of degrees below that of the outdoor dry bulb.

Thus, without the use of cold water or refrigeration, since the water of the humidifier is used over and over again, only that part absorbed by the air being replaced, it is possible to effect a comfortable and healthful condition within factories of certain types, in any locality. In localities where the wet bulb depression is normally very great, such as in our Middle Western states, it is possible to effect a sufficient degree of evaporative cooling even where there is no great internal heat source, the external heat being utilized to bring the air to that temperature at which its relative humidity is comfortable and invigorating.

If evaporative cooling, due to the locality, to the conditions within the plant or to the necessity of maintaining a temperature and humidity below those of the outdoor atmosphere, is impracticable, the cooling can be accomplished by the use of natural cold water from wells or other sources or by the use of mechanical refrigeration. By this method it is possible to maintain any required temperature and humidity regardless of the outdoor conditions.

Weather Can Be Manufactured Anywhere

Thus, no matter what the locality may be or the particular conditions within the given plant, air-conditioning equipment can be applied to establish and maintain whatever conditions of temperature and humidity are most desirable or warranted. It should be borne in mind, of course, that the factor of cleanliness, though not sufficiently stressed in this writing, is of great importance, and that all well-designed air-conditioning equipment provides air that is clean and pure whether the equipment be functioning to humidify or dehumidify.

The initial cost of adequate air-conditioning equipment, when considered on the basis of human efficiency and human comfort alone—that is, exclusive of process efficiency—often appears to be too high to permit consideration. This is because we are unaccustomed to consider human efficiency in terms of dollars and cents. The cost of any apparatus is not measured by the number of dollars and cents involved in its purchase, but by the number of dollars and cents which it can earn for its purchaser. When we have become accustomed to evaluating human efficiency in the same way in which we now evaluate the production efficiency of the machine, the cost of scientific air-conditioning equipment

*If partly saturated air is brought into contact with water, preferably in a finely divided state, and permitted to absorb sufficient water vapor to become saturated, it will be cooled to its wet bulb temperature.

will appear insignificant when compared with the results which it accomplishes.

Leading to the discussion of the effects of air conditioning upon labor it is worth pointing out that when labor is scarce in time of great industrial activity and a command of the labor market is of greatest importance, the condition plant invariably has first call and rarely is unable to fill all of its labor requirements.

The effect of improved atmospheric conditions upon employment may be typically illustrated by the case of a textile manufacturer in Fall River, Mass., who installed a ventilating, cooling and air-conditioning system in his new mill alongside a similar, older mill not thus equipped. All of the employees in the older mill applied for work in the new mill during the first summer of operation, during a time when there was great scarcity of labor. The manufacturer found it utterly impossible to get sufficient labor to run his unconditioned mill to full capacity and efficiency. At no time, however, did he have the slightest difficulty in getting all the labor needed in the conditioned mill. As a result the profits in the new mill during this period of activity greatly exceeded those of the older mill. Another thing that he noticed was the decreased labor turnover in the new mill as compared with the older mill. In fact, the demand for employment in the ventilated and cooled mill was so great that the management found it expedient to offer change of employment from the other mill to the new mill as a prize for exceptional proficiency as well as punctuality and attendance.

The manager of a large New England factory had been experiencing great difficulty during the hot summer weather in keeping the plant operating at capacity. The combined heat of a high outside temperature and the additional heat from the machinery was such that the girls in his employ were frequently taken ill during the day and the routine of the factory was seriously handicapped. The experience made him realize the importance of securing proper conditions, if possible, in his mills, and he made several attempts, with partial success, to improve the conditions. Finally he decided to install a modern ventilating and conditioning system in one of the smaller of his plants, with the result that the difficulties he had experienced in summer were entirely eliminated. This led him to equip all of his old factories, as well as those built later, with the same type of equipment, at great expense, the improvement in labor conditions alone warranting this procedure.

Tobacco Dust Settled and Prevented

Another concrete illustration is a tobacco factory in Richmond, Va., in which mechanical stemming machines are used to strip the leaves from the stem. The dust produced by this process was so great that one could not see the length of the room. Operators had to breathe through handkerchiefs placed over their mouths. As a result, it was found difficult to secure sufficient labor to keep all of the machines in operation and only the poorest class of labor could be obtained. The installation of an adequate humidifying system both settled the dust and largely prevented its formation, the working conditions became measurably ideal and no difficulty was experienced in getting the best type of labor to operate the plant at full capacity and at highest efficiency. Not only was the output of the plant increased, but the labor turnover and cost was reduced and the efficiency of the machines increased due to a better working condition of the tobacco. The annual saving in tobacco alone was more than sufficient to pay for the equipment, besides a material saving in the wear on the machines.

As an illustration of the desirability of properly conditioning the air of buildings in which the process itself is in no way affected, the Ford automobile plant in Detroit may be cited as a conspicuously successful example. Mr. Ford first had his office equipped with a modern ventilating, humidifying and cooling system, and the benefits from it were found to be so great during the hot summer weather that he decided that such a system would give equal or greater benefits throughout his entire machine shop. Elaborate ventilating and cooling systems of this character have now been installed throughout his plants and have become a standard feature of all new construction. The benefits derived are felt to be more than commensurate with the expense entailed.

Individual Efficiency Benefited

While the efficiency of an operator depends largely upon the individual, yet the same individual will do more and better work if in good health and working under conditions of physical comfort and mental contentment. Conditions of excessive dust, or conditions of extreme temperature and moisture, are injurious to health, thus lowering the vitality and driving force of the operative, without which he cannot accomplish the most and best work. He is apt to be frequently absent, due either to sickness or to desire for change. Even though atmospheric conditions may not be sufficiently bad to cause ill health, they may affect the comfort and mental state of the operative to such an extent as seriously to distract him from his work. Such conditions may only be seasonal, as, for example, in summer, while in other cases they may occur only in winter. In a textile mill that is insufficiently ventilated and cooled, the operators will be found opening the windows and spending most of their time standing near them, often to the neglect of their work. Such conditions result in a noticeable loss of production.

Where this condition has become customary, as in old plants, it is often found very difficult to prevent operatives from opening the windows after a cooling and humidifying system has been installed, even though the opening of the windows in no way improves the condition. This seems to be largely a psychological effect and in general it is desirable to provide such a form of ventilating and cooling system that the effect of opening the windows will not be especially detrimental to the operation of the system. In most plants it is desirable to arrange the lower portion of the sash so that it cannot be opened, with a ventilating sash provided in the upper part sufficient only for the exit of air from the building.

In many office buildings where ventilating and cooling systems have been installed, occupants still desire to open windows, although the effect is almost entirely psychological. This practice is not objectionable in summer except where there is a dehumidifying system installed to reduce the air to both a lower temperature and moisture content than that outside. Here it is essential to the efficient operation of the system that all the windows be closed. On this account it is necessary, with a system of dehumidification and cooling, that the temperature and humidity standards be established with due regard to personal comfort, so that there will be no desire to improve the ventilation.

The determination of those conditions of temperature

and humidity most comfortable and invigorating to the human being involves a study which has been prosecuted for many years. Investigations have been conducted by physicians and by engineers. Obviously it is not possible to establish any given condition of temperature and relative humidity as the most desirable, since there are many conditions of temperature and relative humidity—the relative humidity varying, of course, with the temperature—which are comfortable and stimulating. It is true also that indoor conditions which are comfortable in the winter would be extremely uncomfortable in the summer. Nature adapts our bodies to changing conditions with a remarkable facility. Everyone has noticed that in the late fall or first days of winter we are chilled by temperatures which later in the winter we resist without difficulty. It is notable too that the first very hot days of summer are much more depressing than the same conditions later in the summer when nature has adapted us to withstand the summer conditions. Most of us are accustomed to winter temperatures considerably higher than those which are most healthful. This is true because winter air heated to ordinary indoor temperature is excessively dry and does not afford the feeling of warmth, even at high temperatures, as much as 80 deg. F., which the same air would afford at much lower temperatures, as low as 68 deg. F., if the air were moistened to the proper percentage of relative humidity; in other words, 80 deg. air at a relative humidity of 20 to 25 per cent is far less "warm"—i.e., does not produce the sensation of warmth which air at 68 deg. and 50 to 55 per cent relative humidity affords.

The writer has repeatedly observed that individuals—women, for example—who habitually spend much of their time in winter in the home, require, if the air is dry or not humidified, extremely high dry bulb temperatures, even in excess of 80 deg., before they experience the feeling of warmth. Constant exposure to excessive dry bulb temperatures of this nature, the air being as dry as it normally is in an unconditioned building, induces mental and physical dullness and renders the subject highly susceptible to colds, bronchitis and similar ailments of the bronchial areas.

It is notable too that when exposed to high dry bulb temperatures at low relative humidities the human being is astonishingly susceptible to drafts. In very dry heated air nature attempts to protect the body by establishing a film of more moist air in immediate contact with the body. This is assisted by the clothing, which prevents the sudden dispersion of the film by drafts. Thus it is that the draft is most noticeable upon the unprotected skin or upon the ankles and lower limbs which are but scantily protected.

Low Humidity in Houses Is Barbarous

Humidification entirely relieves this unfortunate, indeed it may be characterized as barbarous, condition. The maintenance of a temperature of 68 deg. as a suitable relative humidity (from 45 to 55 deg.) affords complete comfort in stimulating both physical and mental vigor. The dollars and cents value of such stimulation in the case of the worker employed in productive effort, though difficult to compute precisely, is obviously very material.

In the summer, with the outdoor conditions reversed, a number of new factors are introduced. It is well known, of course, that the average person is rarely actually incapacitated by even unusually severe summer conditions, provided those conditions occur gradually, whereas it is equally well known that a sharp change either from hot, humid weather to cooler and less humid weather, or vice versa, will cause extreme discomfort even though the actual values of temperature and humidity in either case are not in themselves extreme or even ordinarily large.

Because of this inability to adapt ourselves to sudden changes in summer temperature, it is not feasible to establish in summer a fixed internal temperature and relative humidity to be maintained every day. It is necessary to establish internal conditions of both temperature and humidity which bear a definite relation to the external conditions. Thus, on a day when the outdoor temperature is 90 deg. and the relative humidity fairly high, the average person experiences a feeling of complete comfort and relief upon entering a building in which the temperature is 82 or 83 deg. and the relative humidity slightly depressed. Again, on a day of 80 deg. outdoor temperature, the relative humidity being high, as usually occurs in August in the climate of New York City, the internal condition of 74 or 75 deg., the relative humidity being materially depressed, affords complete comfort and is extremely invigorating.

Nature's Provision for Changes in Temperature

Because it may foster a more thorough understanding of the subject, it may be well to point out that nature attempts to compensate for excessive summer temperatures by increasing the rate of evaporation from the skin, and thereby affords the body the relief of the consequent evaporative cooling. If the humidity is high, the rate of evaporation is correspondingly low, and it is for this reason that humid days cause us the greatest discomfort. In fact, we ordinarily experience discomfort on very humid days when the dry bulb temperature is well below 80 deg., a temperature which would be entirely comfortable if the corresponding relative humidity were sufficiently low.

The reason why the electric fan offers a measure of relief during summer weather is the fact that the evaporating effect of the air is a function of velocity as well as of temperature and humidity. Thus the draft from an electric fan increases the rate of evaporation and therefore cools the skin, affording the sensation of coolness, although the body temperature is only slightly, if at all, affected. Used unwisely, the electric fan is the source of much physical depression since a draft playing directly upon the unprotected skin of the arms and neck causes a local concentrated cooling effect by evaporation which is extremely difficult for the body to compensate. The electric fan should never be directed immediately upon the body, but so placed that the movement of air which affects the body is induced by the draft of the fan. The danger of this localized effect is entirely avoided in a building which is regulated by means of scientifically designed air-conditioning equipment since the air delivered is distributed through a carefully arranged duct system without drafts and with great uniformity.

It is entirely assumptive that in the very near future the production efficiency of the human being will be considered as carefully as that of the mere mechanical equipment, and that air conditioning will be employed as a practicable means of assuring maximum personal efficiency in any climate at any season under any inherent conditions within the plant itself.

New York City.

Electrification of Chemical And Allied Industries

Electrification of Industry Rapidly Increasing — Use of Motor Drive Is a Help to the Executive — Controllers for Motors Should Be Chosen With Special Reference to the Industry — Proper Use of Electric Drive

By C. B. Gibson
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THE electrification of industrial plants has been a gradual process extending over the comparatively brief period of about 25 to 30 years. During the early part of this period the progress was naturally slower, but during the last 15 years the growth in the use of electricity in the various industries has been considerably more rapid. The original conception of the idea of employing motor drive arose from the necessity for a more convenient and flexible method of applying the driving force to machines.

Some of these machines were of a movable type with unusual motions and often located in some inaccessible place, which did not easily permit of driving by the methods in use then. The many advantages of this then novel method of drive were soon appreciated and motors for driving the more common machines, such as cranes, pumps, conveyors, etc., were soon adopted. A little later group drive and individual drive came into favor, until today electric drive is generally recognized as a necessity for economic and maximum production.

It is also recognized that the electrification of a plant or mill is not merely an engineering problem, comprising the generation and application of motors to machines, but it is one of the most direct, resourceful and accurate means for studying plant development. Unquestionably, electrification of industry has done more to aid executives in the study of plant problems than any other agency, because electrification is power scientifically applied and not merely an adjunct to a manufacturing process; and, further, because it is one of the important factors that lead to more efficient operation, better quality of product and general plant betterment.

Electrification in Chemical Plants

In the chemical and allied industries electrification is probably employed as extensively as in any other industry. As many of the branches of the chemical industry are users of large blocks of power in electrolytic and electrometallurgical operations, it is only natural that electricity be used for the various motor drives in the handling and preparation of the raw and finished materials.

Some indications of the rapid strides in the electrification of the industry are evident from data compiled on this subject. Considering the chemical and allied industries for the year 1914, the percentage of electric horsepower to total power, primary and purchased, was approximately 42 per cent. In 1919 it was approximately 56 per cent and it is estimated that this will reach approximately 70 per cent in 1924. These figures indicate the increasing rate at which electric drive is being adopted. In this connection it is interesting to refer briefly to the government census of manufacturers for 1919. For the fourteen major industries listed, representing the reports of 237,855 industrial establishments, the aggregate primary horsepower is 29,507,717. The number of electric motors installed is 1,483,039, aggregating 16,317,373 hp. This latter figure is made up of 9,347,556 hp. for rented, and 6,969,817 hp. for current generated in the establishment. The 1914 figures compared with 1919 indicate a gradual increase over this period.

While the figures for the strictly chemical and allied industries are relatively a small amount of the total, aggregating 2,043,525 of primary horsepower, they show the extent to which motor drive has been adopted by the industries in this country. The industries provide the major load of the central stations mostly in the form of motor drive, and it is gratifying to note that the central stations fully appreciate this. There is a co-operation and co-ordination of effort which is bound to reflect in a better understanding between the central station and the user.

Advantages of Motor Drive

The main advantages of motor drive are: Lower power costs, increased production, generally improved plant and working conditions and that the greatest return is realized when the entire plant is electrified. The larger the amount of power used, naturally the less the cost per kilowatt unit of energy, due to using greater amounts of power and on account of the diversity factor which means a more even and uniform load condition. Electric drive and automatic motor controllers reduce the amount of skilled labor very materially, as the automatic control device makes possible many self-controlled operations of the motors. Aside from these major reasons, electric drive helps in making a plant a model one in every respect, and this is an important consideration in this day when so much is being done for the welfare of workers. Other advantages are cleanliness, the absence of noise, and the suitability of the electric motor for most drives. Belts and line shafts are eliminated. One of the most important considerations is the ability of an electric motor to maintain the proper machine speed under varying and heavy loads, which in the final analysis means increased production.

Electricity is inherently more economical than steam in the great majority of applications, on account of its high electrical efficiency, low maintenance expenses of equipment, convenience and operating simplicity. Fundamentally, electrification offers one of the best opportunities to develop improvements. It provides an accurate means for determining all phases of plant problems, such as the power required by each machine or in each process. In the chemical industries many processes require extreme and accurate control in various stages of the process, and this is possible with electric drive.

Electrification Helps the Executive

The executive is concerned, among many other things, in reducing costs, increasing output and bringing up profits; and electric drive undoubtedly offers one of the greatest opportunities of accomplishing these ends. To

determine the economies affected through electrification, full consideration should be given of all the factors that may effect the results. Every factor entering into the problem should be considered, and the cost of power is only one of these factors. It is, however, the one common factor in every manufacturing industry, and by reducing the power costs, you can effect savings all along the line.

Practically all the industries welcome the opportunity to purchase power even where conditions might appear favorable for economic generation by the individual plant, because of the greater reliability of central station power and because the average executive feels he can realize greater returns by investing the capital in the business rather than in the power plant. The central stations also have made extensive studies of the requirements of motor drive for the various industries in order to have a better understanding of their problems and to stimulate a more active interest in the future extension of electric power in industry.

Choice of Cycle in A.C. Drive

As to the choice of sixty- or twenty-five-cycle power this is often determined by other conditions or processes in the plant. In several of the large electrochemical districts twenty-five-cycle only is available; and it is only natural that this same frequency be used throughout the plant—for the various motor drives, the haulage locomotives, industrial heating, lighting, etc. Outside of these few districts, sixty-cycle power is the predominating one. The sixty-cycle motors, except in very large sizes and slow speeds, are less expensive than twenty-five-cycle motors, and they offer a much wider range of speeds within certain limits. Alternating current squirrel-cage, wound rotor and synchronous motors are almost universally used, depending upon the type and character of the machine to be driven and the load conditions. Complete lines of these various motors in all standard ratings and speeds and for both twenty-five- and sixty-cycle are available from the electrical manufacturers. A few devices require direct current motors, such as on cranes or where a wide variation in speed is desired. Where relatively only few d.c. motors are used, it is customary to use motor generators for converting alternating into direct current for such purposes. If, however, large blocks for d.c. power are required, as in electrolytic processes, rotary converters are almost universally used on account of their superior operating characteristics, higher efficiency, wide voltage range, compactness and dependability.

Motor Drives in Chemical Plants

In the majority of motor drives in chemically controlled industries, squirrel-cage induction motors are used. They lend themselves particularly to this work on account of the absence of any sliding or movable contacts. This is particularly important where there are explosive fumes or materials present. Some of the applications in which motors are used are for driving conveyors, grinders, mixers, pumps, autoclaves, centrifugals, ball mills, kilns, etc.

While the large majority of drives are satisfactorily handled by squirrel-cage motors, occasionally the starting conditions are such that a motor which gives a higher starting torque must be used. For such cases the wound rotor motor, with reversing controller and resistance for speed adjustments, is most suitable. Again, some drives require mill type motors on account of the severity of the service. For driving centrifugal pumps or compressors, the synchronous motor is often used, and it offers a fruitful field for reduction in power costs. One of the inherent characteristics in the synchronous motor is its ability to improve the power factor of the system to which it is connected. As most central station rates are based on power factor, any improvement in the power factor often reacts in favor of the user.

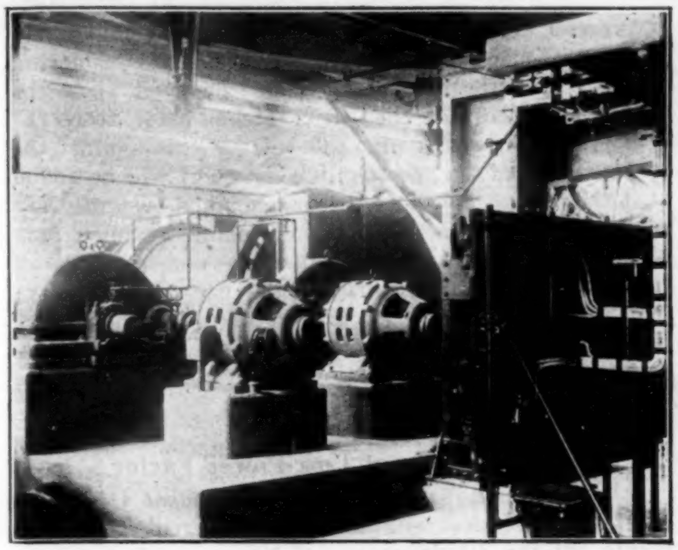
Electrical Requirements of Chemical Industry Severe

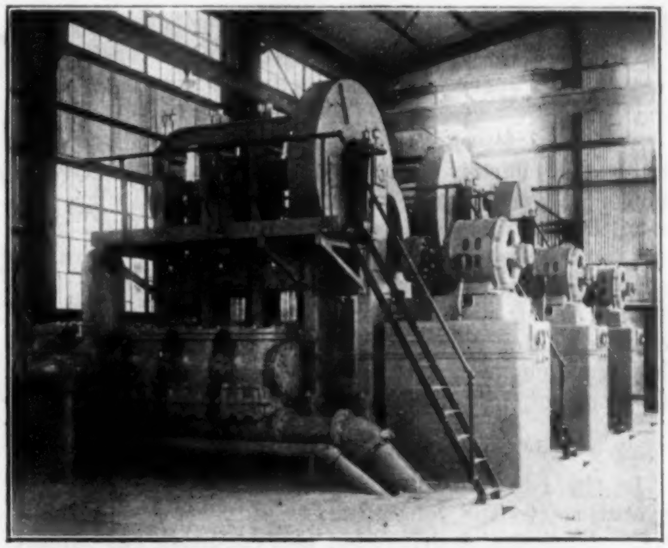
In many respects the service demanded of electrical equipment by the chemical and allied industries is more severe than in any other industry. Here we have the deteriorating effects of acid and alkaline fumes, coal, coke, abrasive dusts, smoke, steam, splashing of liquors, etc. In order to render the electrical equipment impervious to these destructive agencies, especially impregnated coils and windings must be furnished. In this connection it is interesting to note that motors are obtainable with these special impregnating treatments from the motor manufacturers. In a few cases the conditions are so severe that, in addition to these special treatments, totally inclosed or ventilated motors are used as an added precaution. The totally inclosed motor is not obtainable in sizes much above 25 hp. on account of its inability to dissipate the heat developed.

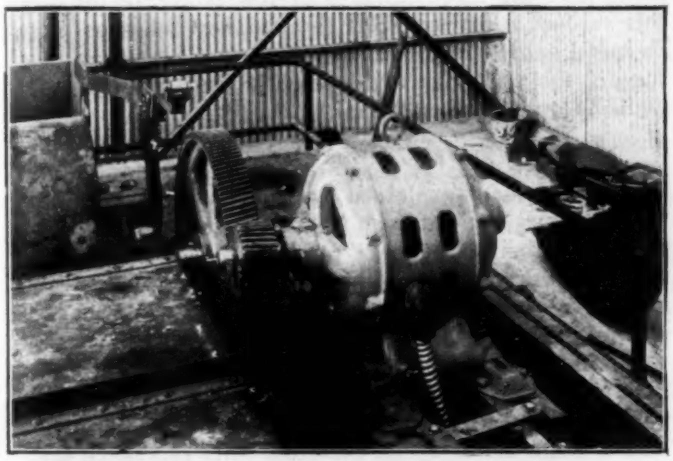
In the larger sizes, ventilated motors are sometimes used. In this type of motor the end brackets are provided with openings. Clean, pure air is piped from the outside to the intake of the motor and the air is exhausted directly into the room. When the run of intake pipe is considerable and the speed of the motor is below approximately 720 r.p.m., the fan blades on the rotor will not provide sufficient circulation of air. If this is the case, or where several motors are to be supplied with air, artificial circulation is resorted to; and a small motor-driven blower is placed in the supply pipe feeding the various motors. For several reasons many users favor the positive method of air circulation for all ventilated motors. In supplying air to ventilated motors, care must be exercised to see that the air is not contaminated with fumes or foreign materials. For some applications a motor with drip-proof covers is sufficient. In this type the end brackets are provided with vanes which divert any foreign materials or drippings of liquor from the motor.

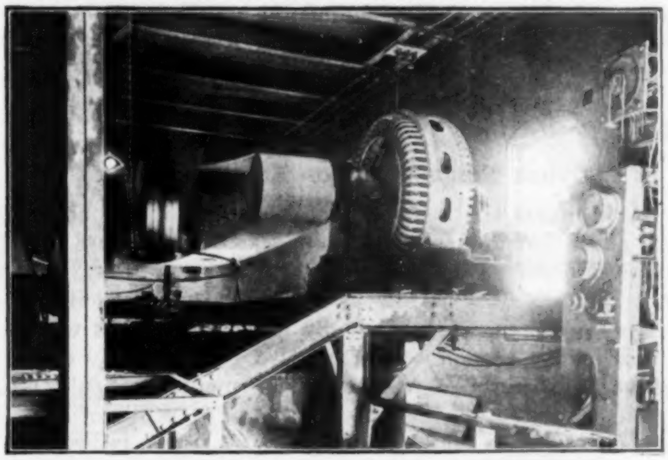
Motor Controllers

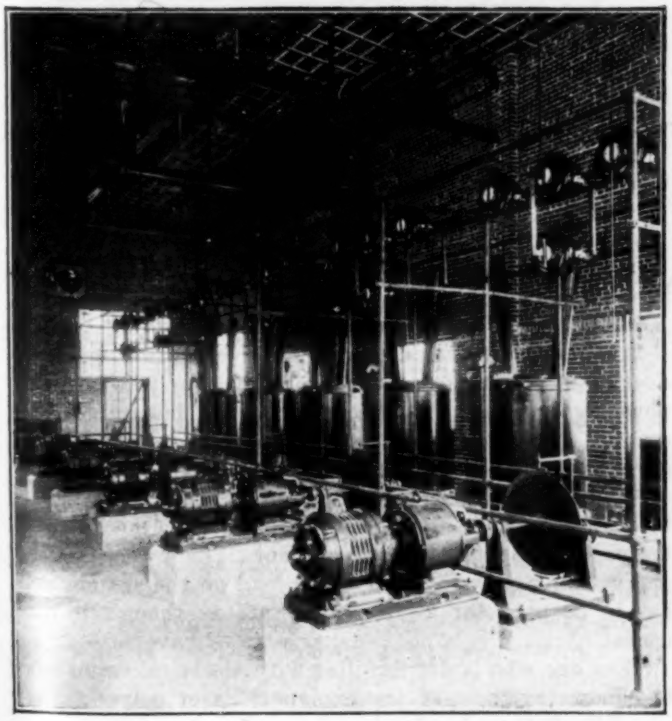
The control equipment employed for chemical plants is equally as important as the motors. There is always a type of control which is best suited and adapted to a particular type of motor. Experience indicates that a full knowledge of the motor characteristics and its performance is necessary in order to properly apply the control. Starters remotely controlled by means of a push button or small master switch are absolutely necessary for certain applications, especially when the motor is in some inaccessible place or where a life hazard is involved, such as in explosive plants. If explosive conditions exist, the completely immersed starter is generally used. In other types of starters where fume conditions are bad, special attention must be given to the contracts, flexible shunts, etc., by treating them with acid- and moisture-resisting materials. It can be con-











LARGE A.C. WOUND ROTOR MOTORS DRIVING MARCY MILLS

25 HP.-A.C. INDUCTION MOTOR DRIVING CONVEYOR THROUGH SPIRAL GEARS

SYNCHRONOUS INDUCTION MOTORS DRIVING GENERATORS AND RECTIFIERS IN COTTRELL INSTALLATION

THREE 125-HP.-A.C. INDUCTION MOTORS DRIVING TRIPLEX PUMPS

A.C. SYNCHRONOUS MOTOR BELTED TO SEVERAL AGITATORS

A.C. INDUCTION MOTOR DRIVING CONVEYOR IN FERTILIZER PLANT

servatively stated that the executive or plant engineer in considering the electric drive can be assured of obtaining properly designed apparatus for all the applications.

While chemistry guides the manufacturing processes of the chemically controlled industries, the electric power is performing its duty silently and efficiently, resulting in increased production, more uniform product, and at minimum power requirements. There are several different types of drive either group or individual, belted or direct connected, etc. The application of these different types is pretty well determined, and is according to a well defined policy of broad plant development, including plans for future growth.

Electrification of Existing Drives

In the past but little attention has been given by executives to the rehabilitation of old plants, usually with steam engine drive; but this condition has rapidly changed and many of these plants have been electrified —using central station power, as it is then unnecessary to invest in a power plant, and the first cost of this change over is a small amount compared with the savings effected therefrom.

Other Possibilities of Electrification

Aside from the motor-driven machines in the chemical and allied industries, large blocks of power are used in electrolytic and electrometallurgical operations. It is not the intention to discuss the use of electricity in these processes, as they usually involve processes which could not be economically employed by using any other source of heat. In passing, brief mention should be made, however, of the possibilities and future of electrical heating in many of the processes. The growth in the use of electricity as a heating agency has been phenomenal. Many executives and others unfamiliar with the possible economies of electrical heating casually dismiss it from their serious consideration, on account of feeling that it is an expensive and impractical method. Fundamentally, there are many reasons why electric heat is superior to any other heat, and these reasons should receive earnest consideration. Some of these reasons are as follows:

(1) Electricity, regardless of the form in which it is used, may be applied at the desired place and in a definite quantity.

(2) The heat may be absolutely controlled.

(3) The central station power is available for heating 24 hours per day.

Applications of Electric Heat

A few of the possible applications in the chemical and allied industries for electric heat are: Heating kettles, vacuum chambers, evaporators, autoclaves, stills, vulcanizers and heating, drying and enameling ovens. The greatest advantages from industrial heating are obtained when the heating process is worked out in connection with other operations and processes. In laying out a plant for motor drive the process can often be improved or the time shortened if the heating processes are considered at the same time. A true estimate of the economies possible can be determined only from a consideration of all the factors entering therein.

The effective utilization and application of electrical power demands the broadest and widest experience and intimate contact with the industry. The executive is interested in knowing the most modern, efficient and economical method for applying power. In considering the electrification of a steam plant, he must know the maintenance cost of the entire steam plant from the coal pile to the crank pin, and balance this against the maintenance of the electric drive; and it will be found that the cost of power is the one common cost in every operation. In considering a new plant, he must consider the most economical processes and methods of handling of materials through the use of electricity; and, in the final analysis, a true valuation of these economies will undoubtedly point the way to worth-while savings through electrification.

East Pittsburgh, Pa.

Disadvantage of Low Power Factor

In a recent issue of *Industrial Management*, George E. MacLean, electrical engineer, of Sherbrooke, Canada, points out the disadvantages of low power factor. As this subject is of particular interest now when so many chemical engineers are considering the electrification of the drives in the plants under their charge, it is worth while to quote, in part, Mr. MacLean's article.

Power Factor Explained

Power factor is explained by Mr. MacLean as follows: "We contract for water at 120-lb. pressure and by some means or other send a back pressure of 10 lb., hence the water will have to be sent out at 130-lb. pressure to allow us to receive 120-lb. pressure, and we will have to pay for this extra 10-lb. pressure."

Similarly, in applications of motor drive, we have a back pressure called reactance—due to induction—caused by running many small induction motors and underloaded large motors. To overcome this reactance there must be supplied an excess of energy over that which goes into useful work. Power factor is the ratio of the useful electrical energy supplied to the total supplied and is expressed in per cent. Hence 85 per cent p.f. means that 15 per cent of the energy supplied is wasted in heating the electrical equipment, and only 85 per cent is available for useful work.

Disadvantages

"Excess heating causes a premature deterioration of insulation, which causes breakdowns and burn-outs of induction motors.

"Low power factor causes another condition with induction motors that does not show itself, as it affects the power consumption and can only be determined by making tests to find out the increase of this magnetizing current.

"Low power factor causes poor line regulation, which in turn decreases the torque of induction motors and increases the magnetizing current. This increase of magnetizing current is an added load on the system and has to be paid for at the same rate as though it was useful.

"For one who is not familiar with electrical terms and trigonometry most of the explanations of power factor are difficult to understand.

"We will say as an illustration that we contract for power at 85 per cent p.f. but can keep the power factor of our plant at only 75, and we consume 10,000 kw.-hr. at 6 mils. Our power bill equals 85/75 of 10,000 times 6 mils, or $67 instead of $60, or 11 per cent of the power bill is paid out for this wattless current."

Increased Production Efficiency in the Industries

Concise Statements by Leading Representatives of the Chemical and Related Industries in Answer to the Question, "What Would Contribute Most to Increased Production Efficiency in Your Industry?"

IN THE following pages the reader will find a group of frank statements by leading industrial representatives. They lay bare outstanding deficiencies in production processes, which, if remedied, will place those industries on a more efficient production basis. Next in importance to maintaining an industry in a state of general health is the frank recognition of weak spots that need improvement, and a vision of possible remedies. In fact, an industry cannot rightly claim to be in a healthy state unless it exhibits that forward-looking spirit that seeks constantly to increase its efficiency in the interest of better service to its clientèle.

Judged by this standard, the chemical and related industries served by *Chem. & Met.* can lay claim to an exceptional degree of vigor and vitality. Certainly it can be said of the least progressive that it has within its ranks one or more men of vision who see clearly what needs to be done in the interest of more efficient production. Their opinions will repay many fold the value of the few minutes required for their reading.

A Neglected Ingredient in Acid Manufacture

BY FRED C. ZEISBERG
Chemical Department, E. I. du Pont de Nemours & Co.

THE chemistry of most of the acid processes in use today has been thoroughly worked out, hence it is needless to look to any great increase in the chemical efficiency of these processes through further laboratory work. How, then, can our acid industry be made more efficient without going to entirely new processes?

Before this can be answered with exactness for any individual process it can be safely asserted as a general truism that improvement can be achieved only to the extent that an exact knowledge is possessed of the amounts of ingredients required to make a unit quantity of the finished product. In other words, it is necessary to have firmly established a thorough system of chemical control of processes and chemical accounting of the ingredients in process.

But this is not all. The amount of labor necessary, and its grade; the amount of repair labor, when this is a separate item; the amount of repair material; and last but not least, the power—all these items must be known accurately.

There are many plants where none of these items is known, except in a general way. There are more where the raw materials alone are known. There are a few where all of the items except power are known. And there are practically none where it can be stated, with any assurance, that so and so many kilowatt-hours and so and so many pounds of steam were used per ton of finished product.

This is a strange state of affairs. In many processes power is one of the most expensive raw materials, yet is shamefully wasted, probably because the coal used to generate it burns up out of sight in the power house and its converted energy flows unostentatiously into the plant through wires and pipes. If these wires and pipes were equipped with meters, so that waste of power and wrongful use of power could be checked up, it is safe to assert that 50 per cent of the power used in the acid industry in this country today could be saved.

In each dwelling house in the larger cities there are generally installed three meters—a water meter, a gas meter and an electric meter. If the public service corporations consider it profitable to install these in order to prevent willful waste of power and to make a proper distribution of the power costs, why would it not be equally profitable to install them in the various houses on a large plant, each of which uses many times the power of the largest dwelling house? Why not, indeed?

Wilmington, Del.

The Fine Chemical Industry Is Dependent on Pride and Loyalty of the American Chemist

BY CARL PFANSTIEHL
President, Special Chemicals Co.

IN THE production of rare and fine chemicals we encounter a new production problem foreign to the manufacturing methods characteristic of America. We are not engaged in moving tons of material, and therefore must shift our interest from that of engineering to the personal element. Germany's monopoly of the fine chemical business in the past was due largely to the fact that she had available a large body of highly trained men of Ph.D. quality, working individually to produce the unusual commodity. Due to the system under which these men worked, their services were obtained at a very low cost.

If we are to make a success of this branch of the chemical industry in America, we must develop a plan whereby the interest of highly trained men can be obtained at a profit to themselves and at a cost which will enable their products to compete with the foreign goods. There seem to be possibilities in the example of a number of young Ph.D. candidates who are making a few rare chemicals "on the side," thus assisting themselves financially and at the same time producing chemicals of value in their particular studies. Another point of equal importance is that in America we have to devise ingenious means of doing work with less labor than heretofore in order to survive. This stimulates the genius of chemists in our industry to devise methods improving on ordinary procedure and substituting automatic control, for example, to decrease the costly element of personal supervision.

In the plant, or more properly the laboratory, appeal must be made to the pride and personal interest of the man who makes the products. It is not possible to institute a discipline comparable to that of large-scale production where tons are handled on a daily schedule.

And although the problems of system and record are the chief difficulties with such chemists—for these men are largely of the research type—the solution of production problems lies in appealing to their pride. The man making fine chemicals cannot be treated as a cog in a machine. His efficiency depends on his skill and knowledge and above all on his interest. This is another argument in favor of the movement now on foot to raise the standing of the chemical profession in the eyes of the public and place it on a level with the medical, legal and other recognized professions.

The chemist must be given this sense of dignity. The intelligent production system must take into account the importance of his pride and interest and give him an opportunity in some way to participate in the profits of his work.

The fine chemical industry is extremely important to problems of American defense, industrial development and public health. It is hard pressed just now and therefore is the most interesting to American chemists and worthy of their loyalty and support.

Highland Park, Ill.

Lost Motion in Explosive Making Due to Needless Variety of Products

By G. M. Norman
Technical Director Hercules Powder Co.

The explosive industry may be divided into three main divisions:

I. Black blasting and black sporting powders.
II. High explosives, usually containing nitroglycerin.
III. Smokeless powders (propellant).

The types of black blasting powder made do not, as a general rule, exceed ten or twelve. The machinery used is rather simple compared to that needed in the manufacture of the two other classes, while only three or four ingredients are required. In our opinion, the manufacture is so well developed at the present time that few improvements may be looked for in the future.

High explosives, comprising dynamite, blasting gelatin, etc., is the largest peace-time branch of the explosive business, judged by the capital invested and the value of the production.

Because of high transportation costs, it has been found advisable to locate explosive plants near the point of consumption. This has resulted in the construction of a large number of factories the aggregate capacity of which is in excess of the present demands or needs of the country. Because of the nature of the materials handled, the industry has not been able to use to the same extent all the various mechanical and labor-saving devices that are common in other manufacturing operations; however, the explosive industry has invented and uses numerous mechanical devices intended to save labor and to reduce the hazard always present in explosive manufacture. In this respect the industry in the United States is far in advance of our friends across the sea; it is only fair to say, however, that the explosive makers of Europe are not permitted by their various governments to introduce mechanical devices, however much they may desire to do so. Hence we think there is little room for major improvements or changes in the mechanical equipment of the industry when producing the present type explosives.

Practically all explosive plants in this country are managed by staffs of technically trained chemists and engineers. The plant efficiencies are high in practically all chemical operations and there does not appear to be very much opportunity to improve upon the results now being obtained.

In the matter of accounting, the principal companies in the explosive industry in this country have a highly developed system of cost accounting, which enables them to determine costs with accuracy.

The one thing we think that would help the efficiency of the explosive industry in the United States today is the standardization of the product. There is nothing new or novel in this statement, and several attempts have been started in the past to bring about a reduction in the almost numberless grades, sizes, styles, etc., in which explosives are placed on the market. The fact is, however, that today there is a greater variety of explosives offered to the trade than is needed or necessary. Who is responsible for this condition—the salesman or the customer—and how it can be remedied we are unable to say. We do know that the result is an increase in manufacturing costs because of a decrease in output of machines due to changing from one grade or size to another, an increase in the amount and kind of ingredients used at each plant, an increase in magazine stocks all over the country and an increase in cost accounting necessary, etc., all of which someone has to pay for.

We very much question if any practical user of explosives can tell any difference between a 17 per cent dynamite and a 20 per cent dynamite, or a 27 per cent dynamite and a 30 per cent dynamite in actual use. Furthermore, we find straight dynamite, ammonia dynamites, high-freezing and low-freezing dynamites, permissible dynamites—both high- and low-freezing—straight gelatin dynamites—high- and low-freezing—blasting gelatin, etc.

There are, of course, thousands of combinations possible under the above conditions. As a matter of fact, the number of different packages in a factory magazine will not usually exceed seventy-five or eighty. This number, however, is excessive, and in view of what has been done in other lines of manufacture to eliminate odd sizes, it would appear that not only an intelligent self-interest of the explosive manufacturers but ordinary economy on the part of the consumer demand that such reduction be made.

Wilmington, Del.

Innumerable Formulas of Fertilizers a Drawback to Production Efficiency

By F. S. Lodge
General Superintendent, Armour Fertilizer Works

From a strict manufacturing viewpoint the one outstanding cause of inefficiency in production in the fertilizer industry is the multiplicity of analyses that every factory is called upon to ship. It seems to be a common belief of scientific agricultural investigators that a properly selected offering of twenty different analyses should satisfy the agricultural needs of any one locality. These, with certain raw materials and bone meals, will satisfy any crop requirement in the territory served by any one factory, with the possible exception of special territories, such as Florida, with its varied fruit and truck crops. In contrast with this we find the average factory called upon to furnish in a single season at least one hundred different analyses of mixed goods, besides raw materials. Many of these

analyses vary by only a quarter or a half per cent in some one ingredient. Certainly our crops are not such fastidious feeders as to demand such slightly varying rations.

The factory, in order to be able to ship any analysis called for, must either carry stocks of individual tags and bags printed to suit each requirement or else be equipped with printing machines in numbers sufficient to print them at a moment's notice. Each extra brand requires that the chemist make out a new formula, that the factory clerk must set up a new set of records in his books and furnish the factory foreman with a new manufacturing order, that the accounting department and auditors have an additional item to carry all through their records.

The most noticeable loss, however, is in the factory, where each change in the analysis shipped by one of the mills requires that the machinery be stopped and cleaned, with consequent idleness of men and equipment. Ingredients and weights must be changed and the entire operation slowed up till familiarity with new figures becomes a routine again, for the intelligence of the average fertilizer laborer is limited and he does not readily adjust himself to varied conditions.

The secret of low cost in the fertilizer factory is maximum tonnage. Every time a mill is stopped to change the analysis being shipped, it results in a loss of approximately 2 per cent of its day's output. Ten changes a day are not uncommon, so that the manufacturing cost of goods shipped is increased 20 to 25 per cent.

This condition in the industry is brought about by the salesman selling anything the customer suggests he wants, rather than what he needs; to his practice of juggling the analysis a fraction of a per cent in the higher priced ingredients, in order to undersell a competitor, and to his offering to duplicate any goods offered by a competitor.

A secondary contributing factor of similar nature and producing the same effect is the non-uniformity of state laws, particularly as to branding of fertilizer packages. A bag of fertilizer branded according to law in one state would be barred from sale and could be confiscated in an adjoining state.

Proper adjustment along these lines will aid very materially in reducing operating costs and increasing operating efficiency.

Chicago, Ill.

Steady Production the Key to Efficient Production in Dye Manufacture

By George A. Prochazka, Jr.

QUESTION the dye manufacturer of today as to the condition of his business, and he will probably recall the latest developments on the embargo and the legislative situation and tune his answer accordingly. These are troublous times for the American dye manufacturer. Granted reasonable protection, it is not impossible for America to compete successfully against foreign dye manufacturers. But in order to do so, it is necessary to apply the same principles of good engineering practice and good business judgment that are essential to the success of any other enterprise.

There are no "secrets" in the dye business. There are a few "kinks" in operating practice which, in the hands of one manufacturer, may give him a temporary advantage over competitors, but eventually such information becomes common property, and he who survives competition will be he who maintains production efficiency by the application of technology and builds up his company by the application of sound business principles.

Production at Capacity Essential

The one outstanding factor in increasing production efficiency in the dye industry today is that of maintaining production at capacity. The dye business is decidedly seasonal. The demand for its products fluctuates in a manner which is sometimes most mysterious. A plant standing idle for a short time will eat up the profit of a much longer time of capacity production. When this fact is realized by the dye manufacturer he will devote his ingenuity to the establishment of a production schedule and a plant arrangement which will enable him to approach the goal of continuous capacity production.

The dye industry has been through boom times, just as many other industries have been, during the war and the post-war period. There are some lean years still to come. The effect of this general prosperity extended to the users of dye as well as to its manufacturers. Many of the consuming industries which sprang up during this period, when quality was a secondary consideration, are now face to face with the necessity for meeting the competition of superior products. Many of them do not know how to use dyes. The hundreds of specialized uses for dyes require a definite knowledge of the best dye for each individual purpose. While the dye manufacturer can co-operate to mutual advantage with the ultimate consumer, it is generally admitted that there is too great a distance between the dye manufacturer and the ultimate consumer. Co-operation would be much simpler if there were fewer middle men, and the manufacturer would be able to meet the individual demands of a customer to better advantage.

Research a Necessity

In an industry which is as fundamentally technical as is the dye business, a certain amount of research is a constant necessity. The value of a research organization, however, cannot be expressed in terms of the number of chemists employed, but must be recognized as directly proportional to the ability of the research staff. In other words, a real research chemist, with years of experience in research, can accomplish much more in a dye plant than a flock of chemists of less experience and ability. Not only in this respect is the personnel in a dye plant important. Eventually, the process is turned over to the operating crew. The ability of these men is analogous to that of a chef, who can concoct a delicious confection from the same recipe that will yield an unappetizing mess when prepared by an amateur. A case comes to mind where one operator had been conducting the same operation in a dye plant for 20 years. One day he died and, naturally enough, took his technique with him, and it was many months before that plant was able again to produce material which was up to specifications.

Cost Accounting of Great Importance

The subject of cost accounting is of the greatest importance in the dye industry, but here again the

extremely specialized nature of the business must be taken into account. The majority of dyes are produced in small batches. Small errors are apt to cause a heavy expense to be laid to some particular product. The production of the various units in the plant fluctuates with the demand. The material accounting must be in an extremely high state of development. The successful cost-accounting system for the dye manufacturer is the happy medium between an elaborate accounting staff, involving considerable overhead expense, and the old-fashioned method of judging the production cost by the aid of that second nature which is acquired by long experience. The common-sense attitude on cost accounting is that any system is worth just about what it saves the company which uses it.

Newark, N. J.

Fundamental Research in Cellulose Industries Must Keep Pace With Commercial Development

BY W. O. MITSCHERLING
Wilmington Experimental Laboratory, Atlas Powder Co.

WHILE the cellulose industry of this country has reached high production efficiency in regard to automatic equipment, improved cost accounting and standardization of operating procedure, little advance has been made in the research of cellulose itself. It is this which would contribute most to increase production efficiency. Our commercial future and welfare depend to some extent upon the cellulose industry.

America is the cotton king; a great deal of wealth of foreign countries depends on our cotton cellulose. While the cotton from Egypt is of very excellent quality, the amount available is limited. This is especially true for cotton to be used as a raw material for cellulose compounds. America also has a great supply of woods of all kinds, sufficient raw cellulose to supply all demands for generations to come. And yet this tremendous industry uses a material the conventional standards of which are defective in every respect.

A bibliographic essay of investigational work on the compound cellulose, either cotton or wood pulp, shows that we have to deal with a highly complex substance whose chemical constitution has not been, as yet, fully determined. The splendid researches of our American scientists and the work of the Forest Products Laboratory give us valuable information about the compound cellulose. While we know the compounds derived from cellulose, we have no light on the manner in which cellulose itself is synthesized.

Thousands of men and women are employed in the cellulose ester industry. The paper and textile industry give occupation to additional thousands of skilled and unskilled workers. A goodly part of the chemical industry is devoted to the manufacture of materials used by the cellulose industry. Manufacturing methods have reached a high state of development, and yet we can scarcely say that our analytical methods for determining the purity of cellulose are exact. It will take time and the co-operation of universities and industrial institutions to work out these methods and to adopt standards.

Let us ask our universities to help us in this work. It is not a question of developing manufacturing processes, it is merely a question of helping the industrial worker to adopt exact methods and standards. To do this the industries must help, not only with suggestions but also financially.

Since the benefit of such co-operation is extended not only to the paper and pulp, the chemical cellulose and the textile industries, but also to the entire chemical industry, there is reason for very general interest in cellulose research.

This would mean increased production efficiency and economy, increased demand for chemists and increased wealth to our country.

Wilmington, Del.

Ceramic Manufacturing Needs More Intelligent Technical Control

BY ROSS C. PURDY
General Secretary, American Ceramic Society

INCREASED production efficiency calls for more ware per hour without reduction in quality or wage. The high wages paid in this country have brought the requirement for more highly productive methods and equipment, which, in turn, has brought the requirement for more positive control methods and records.

Not altogether as a consequence, but paralleling these changes, acting on and reacting with the operating developments, there has been a decrease in number of small plants with their old-fashioned methods and an increase in number of large plants with modern methods. There are 5,000 fewer brickyards in this country today than there were 20 years ago and yet the production of bricks has increased many fold.

The big building enterprises require large building material producing plants. Chain restaurants, hotels and stores call for large producing potteries to fill their current orders. These are some of the present influences that did not exist a few years back.

These are the days of large production per unit labor time of the individual workman in ceramic plants as it is in all other sorts of manufacturing; and there is in the ceramic plants that same increasing need of accurate operating control and better methods and equipment as in any manufacturing.

While there is the increasing necessity for production efficiency, there is also an increasing demand for better quality. This calls for better selection and preparation of the raw materials. Here again follows the need for better control methods.

Standardization and specifications of materials and products are not fads; they are economic necessities. Elimination of shapes and sizes is not a fad; it is an economic necessity. Cost records and their analysis are not fads; they are economic necessities.

In the manufacture of some ceramic wares they are finding some of the machine processes inadequate from the viewpoint of both cost and quality. There is today more casting of large wares, complicated shapes and even of some of the simple shapes. Just as the foundryman has learned the economies of jogging, of stacking and of gang molds, so have clayworkers. The glass manufacturer today is more dependent on automatic machines because of the necessity to increase production per labor hour, and to meet the more strict specifications of product.

New designs of kilns, driers and handling devices, together with closer inspection of materials and products, are the economic requirements of the present day. The processes and equipment that effect economies in one ceramic line will not always effect them in others. Car tunnel continuous kilns have produced economies and higher quality of ware in some ceramic lines, while

in others the cost records show in favor of the periodic kilns. Under some conditions gas producers are economical, while under others they fail to show economies of any sort. But there is no kiln, process or equipment which cannot be made to produce more efficiently by subjecting its operation to close control observation. The recent demonstration by the Bureau of Mines on a variety of brickyards of the possibility of from 15 to 30 per cent saving in fuel, quicker turnover of kiln without a change in kiln, fuel or labor and with more positive control of quality and a reduction in amount of "seconds" bespeaks the economic importance of technical control in manufacturing of even so crude a ware as common bricks.

Increased production efficiency today will follow from the more searching technical and scientific investigations which the manufacturers are supporting both in groups through trade associations and singly. The consequence of these investigations will be closer and more intelligent technical control. This is the greatest need in ceramic manufacturing today.

Columbus, Ohio.

Standardization of Product and Process Needed in Pulp and Paper Industry

THE greatest present needs of the pulp and paper industry to insure increased output consistent with quality and decreased costs are the establishing of standards at commencement and throughout the stages of manufacture and such technical control through men and instruments as will maintain conditions commercially close to established standards.

Our raw material is handled in such quantity and from so many sources that any inspection and sorting much better than at present would be prohibitive in cost, so that an established standard should be such as can be reached easily and maintained through mixing and averaging lots of material received. After receipt and before going into process much good work can be done along the line of improved storage of wood, uniform moistening, rotation of piles, etc.

While in one sense not a raw material, the water supply certainly enters into the process very vitally. Equipment in settling basins, filters, chemical treatment should be ample enough to insure substantially uniform water throughout the year. Even temperature can be kept approximately uniform through use of heat interchangers, condensing water, etc.

Throughout the process the strictly chemical ends, such as preparation of liquor, bleach, etc., are pretty well measured and controlled, but the physical end as exemplified in mechanical handling and measuring of semi-colloidal stock offers a large field for effort. The work of both chemists and technical mechanics should be directed toward uniform material delivered to machines. In the case of somewhat parallel processes where raw stock is necessarily variable, very definite schemes of mixing and averaging have been adopted. The pulp mills can improve materially along this line.

Initially the chip house can be made a much more exact process, chipper and chipping put nearer on a par with planing mill practice, and screening and sizing chips can be done much more carefully, each size later being given its proper controlled cooking time.

Digesting apparently must be a batch process for some time. It is therefore all the more important that large storage capacity be provided after the digesters, so that the inequality in the various cooks be ironed out and stock going to the drainers, bleachers, etc., be average of many cooks.

Bleaching is pretty well controlled technically, although a decided weakness exists in the means of maintaining stock consistency. Devices are badly needed that will be simple and substantial, that will indicate not only stock consistencies but freedom of the stock.

Proper beating is at present far too much a matter of opinion. With proper instruments showing power input, weighting of roll, coupled with standard inspection of the condition of beater and Jordan knives, the stock to the machine chests could be delivered in a vastly more uniform condition than at present.

At the machine we need close control of room humidity and temperature, uniform speed calling for removal of vapor, drainage of driers, close speed regulation and uniform steam pressure.

In the finishing room and coating mills there is not so much room for improvement, though better humidity control when drying would make for better paper grades.

Freedom from fire in paper mills and other manufactures is largely a matter of inspection and installation of protective devices. Why will not similar anticipation of trouble in the process through technical inspection and follow-up of machinery result in equally large dividends?

The technical personnel end is perhaps the most difficult problem to solve. We have seen in the last decade the establishment of chemists as a necessity to paper making. The introduction of technical mechanics may not follow the same methods. The latter must be brought in through establishing prescribed courses leading to a fairly definite executive job about as the large electrical companies maintain their technical forces.

Sound Advice for the Petroleum Refiner

By T. G. Delbridge
Chief Chemist, The Atlantic Refining Co.

IN reviewing the problem of increasing the efficiency of petroleum refining, there appear to be three factors that warrant the careful consideration of every petroleum refiner:

(1) Utilization of experimental data now available.
(2) Further scientific study of process problems.
(3) Judicious selection of products to be manufactured.

While the scientist is rapidly becoming more indispensable to a modern refiner, there is still, in some quarters at least, a mild antagonism toward the college-trained man. His results, conclusions and recommendations are sometimes looked upon with doubt and suspicion. A perfectly practical and financially attractive process may lie dormant in laboratory files for months before being taken up. In general, the solution of any problem represents only half the necessary work, the other half being to sell the idea to the management. It is proper and necessary that every new project be carefully scrutinized. Such scrutiny, however, should be prompt and decisive. Delay is not only expensive when good ideas are neglected but is extremely discouraging to the scientific staff. It is suggested, therefore, that the first step in increased efficiency is prompt utilization of all scientific information available either from private or public sources.

The second item in the list needs but little comment.

While refining operations will probably always require the exercise of some personal judgment, it is highly desirable that this be reduced to a minimum by controlling conditions in such a manner that the desired result follows not once but always. This requires careful and thorough scientific study. The greatest foe to progress has been impatience and guessing. Obviously, scientific information can be obtained only with a competent staff large enough to cope promptly with the more important problems and so co-ordinated within itself as to function smoothly with the operating organization. Such a scientific staff will quite naturally furnish about half the operating executives of the future, and at least some of its men should be selected with that objective in view.

The third suggestion is a plea for more care in deciding what products should be made. Granting that the customer is always right and that he must always get what he wants, nevertheless it is frequently necessary to assist him in determining what he wants. The present age is one of specifications and there is a real tendency to overdo in this respect. The pendulum is swinging from the position where the customer took what he could get to that where the customer will tell the refiner what to make. While there can be no criticism of a rational specification, even for petroleum products, there are many instances where the refiner bears an excessively high cost to produce a product of inferior value to the user. There is a grave danger along this line. Highly refined products are not always desirable. For certain purposes they may easily be over-refined. The interests of both user and refiner are identical so far as petroleum products are concerned—namely, the most satisfactory material for each purpose in quantity to meet but not over-supply the demand.

Philadelphia, Pa.

Research on Design, Quality and Uniformity Essential to the Rubber Industry

By W. C. Geer
Vice-President in Charge of Development, The B. F. Goodrich Co.

THE rubber industry is distinct from the pure chemical industries, in that the majority of articles made, particularly tires of various kinds, undergo service of a character which wears them out. There is a life or endurance factor, whereas in chemicals the substances made usually must withstand a composition requirement only. In rubber goods, therefore, there is ever in front of the production engineer the question of design, which must be maintained so that each of the numerous units may render to the consumer the full measure of service.

A major problem of production efficiency is so to produce the millions of tires, heels and shoes, the miles of hose and wire in a way to maintain in each of them an endurance quality. It is probable, when one considers the tire production of over 35,000,000, a boot and shoe production of over 160,000,000 and the many millions of feet and numbers of units of the various other articles, that there today exist differences in quality.

The rubber industry today is well manned, the skill of its workers and their selection and training are high. But the production efficiency engineer should for some time bend his energies toward harmonizing labor and processes that each unit may equal in service value each other unit. This, in my judgment, is the next most essential step before the maximum achievement of production will be obtained.

Co-ordinated with greater uniformity of production lies the field of more fundamental research. Much has been accomplished, particularly during the past 5 years, along special lines, which, however, have had to do with improvement in the details of methods of manufacture of articles now known. Accelerator work and reclaiming of old vulcanized rubber are the two greatest advances made since the discovery of the fundamental one of vulcanization, but methods of mixing and methods of handling unvulcanized rubber are still much as they were 70 years ago.

Research to give greater adaptability of rubber compounds to broader uses and thus to give to the consuming public the advantages which rubber, of all substances, possesses is still another field. We know that the quantity of crude rubber to be derived from plantations is practically unlimited. Therefore the manufacture of numerous products not now made of rubber, by methods so economical as to permit of the extended use of such new products, is a field of investigation vast enough to occupy the attention of the best construction and production engineers in the industry.

Akron, Ohio.

Need of Research in the Portland Cement Industry*

By P. H. Bates
Chief, Division of Ceramics, U. S. Bureau of Standards

NOTHING has served to demonstrate to the portland cement industry the possibilities of increased production efficiency more than the results which have been obtained by the installation of properly designed waste-heat boilers and the power plant equipment required by such installation. Though it is true that some of the first to attempt the use of such waste-saving devices met with dismal failure, yet those who continued development along these lines, or the others who studied the first failures, have met with such success that now all concede the marked increase in plant efficiency obtained by the use of the waste heat recovered from the rotary kiln. If a plant with but three 150-ft. kilns can generate from the heat formerly wasted by these not only enough power to run the entire plant but sell an unrequired surplus, what more striking example of the possibilities in production efficiency could be desired?

What Is the Most Efficient Length of Kiln?

Such results have been obtained by the first intensive study of but one feature of plant equipment. There is reason to believe that the study of all the other features might produce as highly gratifying developments. Hence why not continue the study with the kiln and determine the most efficient length of kiln for any type of raw material and the proper ratio between length and diameter? Kilns now vary from 6 to 12 ft. in diameter, and from 60 to 240 ft. in length.

The settling, for the time being, of the fineness requirements in the standard specifications for cement is too recent to have dropped from the memory of many. The discussion of this will be recalled to have hinged upon the ability of certain of the common types of grinding mills to produce the fineness of product asked for by many and upon the cost of such extra grinding by any type of mill. It served to bring out strikingly the fact that the type of mill used was largely a matter of personal preference, without any basis of actual data

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of the efficiency of the various types used. Here again the question is not one of variety alone but also of size. What should be the ratio of length to diameter of tube mills, or what should be the diameter of the various types of ring mills for the greatest efficiency?

Research the Important Factor

There can be no doubt that the most important factor toward increasing production efficiency in the portland cement industry would be research, especially along the lines of operation of the mechanical plant and leading toward the standardization of plant equipment. This is suggested without even considering the need of research along chemical lines such as might lead to certain changes in composition or raw material as would reduce the clinkering temperature or the need for the usual degree of fineness of the raw material. It is suggested also without regard to the desirability of research to determine whether portland cement as now made is of the proper composition for all purposes, or without regard to investigations which might lead toward such radical changes in production procedure as recently brought forward in France with the appearance of the "fused cements."

Mechanical research is the feature which can bring in the shortest time to this huge chemical industry—the manufacture of portland cement—the greatest increase in production efficiency. While it is to the credit of the chemists and chemical engineers that this industry has grown from nothing to a value of annual production of close to $225,000,000 in somewhat less than half a century, yet for this industry to gain the efficiency of production that will be demanded of it to bring it to the level of the other chemical industries, it will be necessary for the chemists and chemical engineers to see that research is directed along these lines.

Washington, D. C.

More Engineering Research and Standardized Raw Materials Needed by Paint and Varnish Industry

By C. D. Holley
The Sherwin Williams Co.

SIXTEEN years of practical experience in the manufacture of paints and varnishes has convinced the writer that standardization of raw materials is by far the most important step to be taken in obtaining increased production efficiency in this industry. Except in a few instances it has been a matter of extreme difficulty to purchase these raw materials on a fair specification basis. Possibly this is due to the fact that very few paint and varnish companies have attempted to buy on specifications and the various sources of supply have therefore not felt the need of standardizing their products or giving to those companies which endeavor to purchase according to specification the consideration to which they are entitled.

Many of the larger paint companies attempt to run on established production schedules, and unless their incoming stocks of raw materials are uniform in quality, the rate and, therefore, the cost of production are interfered with—often quite seriously. This is particularly true on account of the fact that most paint factories use a minimum of skilled labor.

It is the writer's belief that other features which work toward increased efficiency, such as automatic process control, improved machinery and facilities for handling and conveying raw materials, efficient training of workmen, are of secondary importance as compared with the problem of obtaining uniform raw materials. This is largely because of the fact that these materials constitute a large portion of the cost of the paint or varnish in question.

Fundamental research should not be neglected, and particular attention should be directed toward a better understanding of the underlying principles of paint grinding. The necessity of this is shown by the fact that there is today no standard or generally accepted type of dressings for paint mills. Probably no other industry knows less about the possibilities of its equipment than does the paint grinder. Perhaps this is not to be wondered at, as the paint and varnish industry has until very recently given but little thought to engineering research.

Acme White Lead & Color Works,
Detroit, Mich.

Fundamental Research on Purification Methods the Greatest Need in the Beet Sugar Industry

By H. W. Dahlberg
Research Manager, The Great Western Sugar Co.

THE beet sugar industry is in one way fortunate in having only one main product—white granulated sugar. The quality of this product is all that can be desired, it being of a very high degree of purity. The greatest possible advance in the industry during future years will therefore doubtless be along the lines of increased quantity per dollar expended, rather than in improved quality.

I believe the greatest need of the industry today is more fundamental research, particularly in several of the most important steps in the process of extracting and refining sugar from beets. The lines of research which look most promising to me from the practical "dollars and cents" standpoint are the following:

1. The production of beets of high sugar content and minimum amount of soluble impurities.
2. The elimination of impurities in the refining process.

The quality of sugar beets varies greatly with soil and climatic conditions. While climatic conditions are beyond our control, we do have some control over soil and irrigation. It has been well demonstrated that beets which are grown in heavily manured soil, or soil very rich in soluble salts, are relatively low in sugar content and of a low purity. The same is true of beets which have not been carefully thinned and cultivated, or have been watered excessively with irrigation water containing mineral salts. In order to obtain beets of high quality it is necessary to start with carefully selected seed into which the desired attributes have been bred through many generations, and follow up with scientific soil treatment. In a period of 30 years preceding the war several of the European countries, by systematic seed breeding and selection and studies in fertilizer control, were able to reduce the mineral salts in beets by 30 per cent and increase the sugar content very materially. While our naturally rich soils do not respond so readily to fertilizer control as do some of the European soils, I believe research work conducted from both the botanical and chemical standpoint will yield large returns in securing beets of maximum sugar percentage and purity.

The principal purification of juices from sugar beets is done by treatment with lime and carbon dioxide. By

this treatment about 25 per cent of the impurities present in the juice are eliminated, the remainder causing a loss of sugar in the form of molasses, from which sugar cannot be extracted except by special processes. This purification step is by far the most important in the entire refining process, and it is rather surprising that no essential improvement has been made in it during the last 50 years. A great deal of research work has been done on the whole problem, but progress has been slow due to the complexity of the reactions taking place and variations in the composition of the juices. Recent work indicates that colloidal chemistry may play quite a part in securing a greater elimination of impurities, some of which are colloidal. The problem is now being attacked from this standpoint, with some promise of ultimately reducing the loss of sugar in the form of molasses.

Many other problems of almost equal importance remain to be solved. After some years of research work in the beet sugar industry the writer is firmly convinced that more fundamental research will yield very handsome returns in increased production efficiency and greater yields of sugar.

Denver, Colo.

Machinery Cannot Displace Human Factor in Food Products Industry

By F. E. Barbour
Vice-President, Beech-Nut Packing Co.

IN THE food products industry, perhaps to a greater degree than in any other, the main element of production efficiency lies in the human factor.

Give six cooks the same recipes, the same materials, the same utensils and the same kitchen; give them free rein, let them all work at the same time—and you'll get six different results.

Enlarge this kitchen to the proportions of a modern food products factory equipped with the most scientific methods and machines, and you're face to face with the same problem—how to train the people to use to the best advantage the tools given them so that a uniformity of product results.

To select and train these workers properly is a big problem. A bright, sunlit factory with ideal surroundings and pleasant conditions attracts plenty of recruits, especially if word goes out that "it's a nice place to work." But the sifting-out process requires time, patience and expense. Personal neatness, deft fingers, accuracy and speed all count. But proper credit for each, with equal debit for lack of any one, must be regulated sharply and with a kindly spirit.

Foods, to receive the approval of our pampered American palate, must reach the manufacturer's highest standard in every package. Folks are more finicky about the way their food looks and tastes and smells than any other commodity of daily use.

Machines may make the products, chemists may announce the calories contained, but, like the pancake artist in the restaurant window, the person concerned in the preparation is the greatest element of all.

Each manufacturer must work out his own methods of training, but all center around one big idea—treating folks well. The physical properties of the plant, the traditions of the product and the ideals of its maker quickly tell the worker what is expected of him. Encouragement to study his fellow workers who progress most rapidly teaches him how he may advance.

Bulletins giving testimonials of satisfaction from users of the product impress him with this personal responsibility. Occasional trade gossip, such as acceptance of the product by large users, gives him a hint that the management appreciates his efforts as well as those of the sales force.

A suggestion box asking for his ideas makes him feel that he is more than a mere machine. An inside house organ, the company library, varied recreational and beneficial activities which come under the head of "welfare" work all serve to train men and women for the best interests of the company and its products.

Improve machines as you will, all is worthless unless the operators are better than the machines. Manufacturers of food products are wide awake to the importance of cultivating their personnel. Any reader of *Chemical & Metallurgical Engineering* may satisfy himself along these lines by a visit to the plant of any well-known and nationally advertised food product, and talk to the people themselves.

The success of the product is measured only by the satisfaction of the people who make it.

Canajoharie, N. Y.

Management's Reluctance to Use Technology in Wood Distillation

By F. J. Root

FOR a term of years the writer was firmly convinced that his own industry, wood distillation, was being managed as a whole in the most unprogressive way, particularly in the attitude of its owners regarding research and improved methods. As my horizon broadened I came in rather intimate contact with engineers, chemists and laymen in other lines of endeavor who were equally sure their own industry was least progressive. So it appears the super-conservative policy has been unfortunately general; too often when a chief executive was approached with an improvement in efficiency he at once turned it down, saying in effect, "I would as soon try to pick the lock on a morgue."

This managerial attitude has led to some highly humorous disease pictures in industry. One illustration may prove of interest. The gum turpentine business in our Southern States is very old and quite extensive, consisting of scattered plants each of which must have a copper still. Up to about 10 years ago these were actually run without the use of a thermometer. But finally an enterprising man took an ordinary thermometer, put a few simple marks on the scale for convenience in remembering the boiling point and went out selling one to almost every still owner and charging them something like $100 each!

These Southern stills had been in operation for three generations and during that time there was not enough accumulated enterprise to make use of a common thermometer. Hence one must commend the man who introduced heat-measuring equipment, even though he did charge twenty times the market price.

Manufacturers are inclined to believe in authentic history if it is not technical. Why not accept the technical, provided it is well compiled and reliable? The gum still incident cited is comedy, but it is also tragic history, because all those years the stills ran without thermometers and it meant a loss of goods—probably 10 per cent of all the turpentine. This in turn meant the unnecessary cutting of many thousands of acres of prime forest.

Plants can run without research just the same as

gum stills can run without a thermometer, unsatisfactorily; just the same as an army unit can go into action without its observation balloon, blindly.

Wood distillation can do without either improved methods or research if the management is willing to keep a large percentage of its plants idle, as is now the case. Likewise it can do without raw material provided always it does not care to operate its plants.

Research is a business. Even that overlord the banker is coming to recognize this, and there are other substantial indications that the day is at hand when the ultra-conservative elements will be swept into the discard and when the technically progressive will be in the ascendant.

Chicago, Ill.

Mechanical Improvements vs. Fundamental Research in the Leather Industry

BY JOHN ARTHUR WILSON
Chief Chemist, A. F. Gallun & Sons Co.

MANY complicated processes of unknown mechanism and a vast amount of time and labor are involved in the manufacture of leather, making this a fertile field for studying methods of increasing production efficiency. The most obvious means of lowering production costs is the replacement of manual labor by mechanical appliances which perform the work more quickly and reliably and utilize sources of energy much less costly than man power.

In many plants the tanning of sole leather requires 6 months or longer, during which each hide must be handled many times. When enterprising mechanics began to exploit this field, the sole leather tanners were not slow to adopt the use of time- and labor-saving devices wherever it was clearly demonstrated that the introduction of new systems effected a real saving in the cost of production.

But the writer believes that the opportunities for increased production efficiency lie less in mechanical improvements than in fundamental chemical research. Six months of work is required to tan sole leather in many yards simply because the tanners have a process that requires it and they do not know how to get the same results in any less time or with any less work. Mechanical improvements may make the process operate more efficiently, but they do not change the process itself.

Fundamental chemical research on tanning has been in progress at Columbia University during the past 4 years and many valuable papers on the subject have been presented before the Leather Division of the American Chemical Society at its annual gatherings. Yet how many tanners today appreciate that the rate of tanning, the rate of penetration of tan liquor into a hide, the degree of plumpness of the leather and its color and smoothness are all controllable chemically? Much of the work that men are now striving to do more efficiently by mechanical means will probably be eliminated entirely through fundamental research.

Although a campaign of education may be necessary to show the tanners what chemistry has to offer the industry in the way of possibilities for increased efficiency, it is scarcely likely to succeed unless it clearly differentiates between the value of the science of chemistry and the mental limitations of many of its followers. A British tanner once explained to me how he had proved that chemistry had no application in his plant. He hired a young graduate for the munificent salary of 30 shillings per week and sent him straightway into his color room with the challenge to show how chemistry could improve his system for dyeing leather. The young man naturally was helpless and the tanner tolerated him only for a few weeks. Still the tanner did not begrudge the loss of the few shillings it had cost him, because it set his mind at rest on the subject of applied chemistry in the tannery.

What the industry needs are the most highly trained physical chemists available. If such men enter the industry with a reasonably clear appreciation of the truly remarkable development of the art of tanning and learn to use their training to supplement, rather than replace, the art of the tanner, the result will probably be an increase in production efficiency greater than would ever be possible by the introduction of mechanical improvements alone.

Milwaukee, Wis.

Intelligent Scientific Control Essential to the Lime Industry

BY WARREN E. EMLEY
Bureau of Standards

CONTROL—intelligent control—is undoubtedly the answer to the question, What can the lime industry do to increase its production efficiency?

Ten years ago there were few limekilns making more than 3 lb. of lime per pound of coal. Today there are few making less than 5. Fuel efficiency doubled in 10 years! This is an achievement of which any industry might justly be proud.

This was accomplished because competent engineers made a careful study of kiln design, fuel combustion, heat distribution and temperature control. The facts which were discovered were put into practice. Pyrometers and chemists have come to be important factors in the operation of a lime plant.

While congratulations are in order, one should remember that the fuel ratio theoretically possible is about 14 lb. of lime per pound of coal, so that there is still room for further improvement.

However, fuel efficiency is only one item of production efficiency. The sale of the product should be studied just as carefully as its manufacture has been, and should be subjected to the same degree of "intelligent control."

Years ago one used to hear statements like this: "The stone in my quarry is not so pure as that of my neighbor. I can't make as good lime as he can, but it is not my fault." The modern version of this story shows a radically different viewpoint: "My neighbor makes a good building lime, but he is getting only $6 a ton for it and he can operate only 8 months a year. My stone will not make good building lime, but it is much better than his for making bleach. I will sell it for that purpose, where they pay $9 a ton and the demand is steady throughout the year."

The modern lime manufacturer has discovered the fact that no lime can be called good or bad unless its use is considered. A lime which is excellent for one purpose may be unfit to use for some other purpose. For this reason it is necessary for the lime manufacturer to study the way in which his lime is used. It is only through a thorough knowledge of his customers' requirements that he will be able to make the best lime to meet those requirements.

The old idea was to make the "best" possible lime from the stone available, the definition of the word

"best" being based on the opinion of the lime manufacturer. This lime was then sold for a variety of purposes, for only a few of which it was suitable. The modern idea is to let the customer define the word "best"; to study his individual needs, and change the process of manufacture in such a way as to produce the kind of lime best suited to meet those needs. This, of course, involves accurate and continuous control not only of the manufacturing process but also of the sales organization, to see that each particular kind of lime is used only for the purpose for which it is best adapted.

Intelligent control includes not only the control over the manufacturing process and of the sales but a far more important idea: the lime manufacturer must control his opinion of the quality of his lime, and make it subservient to the opinions of his customers.

Washington, D. C.

Economic, Not Technologic, Considerations Govern in the Gas Industry

By R. B. Brown
General Manager, Milwaukee Gas Light Co.

THE technical situation in the gas business today is confused. There are so many conflicting views as to the future that any authoritative statement as to what can or should be done is not possible. But in general all will agree that economic, not technologic, considerations govern the industry at present.

Gas companies are not financially in a position to make drastic changes in plants. Rates are believed by the public to be exorbitantly high and are known by the operators to be inadequate to attract new capital that is needed to take care of anything more than needed actual extensions of plant and distribution systems.

I believe a great deal of progress will be made in the design of carbonizing equipment along lines that have not been given any thorough tryout as yet because of the fact that up to very recently drastic heating value and candle-power requirements prevented any such thorough tryout as is necessary to develop and perfect any new method of handling. However, we shall have to feel our way, partly because of ignorance of possibilities, but more because of the limitations financially.

The future of the business from the standpoint of the volume of sales is tremendous. We don't any of us know anything about the saturation point. So far as our ability to supply is concerned, it will be taxed for years to come along the lines of present endeavor. But during such a period as this, to revise all methods of manufacture and distribution, to amortize the capital thus involved and at the same time to provide earnings to attract new capital in enormous quantities—well, it is a proposition that can't be "put over."

The Question of Rates

Rate structure is another subject which is very much to the fore. The obsolete rates now generally in effect in the sale of gas in this country permit the extremely small user (who is increasing in numbers through modern methods of living in apartments and taking meals elsewhere) to abuse the privilege which, under these rates, he has of compelling the company to maintain a meter, service and a readiness-to-serve without any compensation or in some cases with partial compensation for the actual cost.

The difference in the investment required for different types of consumers, with their varying demands and load factors, is so tremendous that this problem alone will probably receive a great deal of attention for years to come before any even approximately adequate solution is reached.

Reduction of Investment Per Unit of Output the Problem

The technical problems are not being neglected in the meantime, but they do seem insignificant in contrast with the great problem of fixed charges on investment. What we need is greatly to reduce the investment per unit of output. Some progress has been made, but much more is essential to reduce the capital charges per thousand feet of gas and per unit of byproducts made.

Complete gasification of coal promises much in this direction, but as yet this means is limited by official requirements as to the heating value of the gas. Others argue for low-temperature carbonization as a cure-all. But there one finds a technologic limit. In any event these or some other such schemes must be evolved which will free the gas from the excessive burden of interest, depreciation, amortization, taxes and profit on the large investment now required for each thousand feet of gas sold. "Cheap" gas service cannot possibly carry such a load.

The byproduct possibilities of the industry suffer quite as much as the gas. They may, with high capital charges, even reach the point of creating losses rather than added net income. In fact, in many cases now there are plants which do not find it practicable to recover some available byproduct, because the investment and labor charges per unit made preclude profitable marketing of them.

Real progress in the gas industry will, in the end, certainly come from improved technology. But those who contribute to this progress must give quite as much attention to reducing investments and unit costs for labor as to yields per ton of coal or B.t.u. per foot of gas. The dominating factors in the industry will certainly for some time be financial and economic.

Milwaukee, Wis.

A Co-operative Research Program for the Vegetable Oil Industry

By L. M. Tolman
President, American Oil Chemists' Society

IT IS the opinion of the writer that the most important development of the past year and the thing that gives greatest promise of increasing production efficiency in the edible-oil industry is the plan of co-operative research along the lines of the fundamental questions involved in the refining and handling of edible oils. The joint research committee of the American Oil Chemists' Society and the Interstate Cottonseed Crushers' Association, working in co-operation with the United States Bureau of Chemistry, has under way some very important investigations regarding the composition of the non-fatty substances in crude cottonseed oil and other crude oils. This investigation is undoubtedly fundamental in the advance of our refining methods which at the present time are based on the more or less empirical methods adopted 10 or 15 years ago as the result of the cut-and-try experiences of practical refiners. Progress in the production of edible oils will undoubtedly be along the line of real fundamental research in refining methods. At the present time refining losses are admittedly much higher than they should be.

The research work which can be carried on by the

governmental departments is necessarily limited, and while the results so far obtained are going to be of great value to the industry, it would appear that the edible-oil industry itself would make much greater progress if it could organize its research work in a co-operative way, either by the establishment of research organizations supported by the industry or by the endowment of fellowships in the existing research organizations. It is the writer's personal opinion, however, that much more important results could be obtained, and they would be obtained in a shorter time, if the edible-oil industry of this country would establish a research organization of its own for studying the problems in regard to the refining and handling of crude vegetables.

Laboratories, Wilson & Co.,
Chicago, Ill.

Further Improvements in the Soap Industry Must Come From Chemist and Chemical Engineer

By Martin Hill Ittner,
Chief Chemist, Colgate & Co.

I DOUBT that there is any important industry that does not offer opportunity for increased production efficiency. As there are believed to be large fish in the sea still waiting to be caught, so too there are, no doubt, great improvements in industries awaiting the discerning eyes of wide-awake chemists and chemical engineers.

The soap industry has been subject to some intelligent investigation during recent years and most of the methods now used are good. Within the limitations of a brief statement such as this, it is possible to indicate only a few of the things that may lead to future improvements.

Small units require more labor and more steam for a given amount of material handled than large units, and the large soap pans in use in some factories show that certain manufacturers have already learned this fact to their advantage.

Just as open and closed steam coils have proved immeasurably superior to fire heating, and as pumps are more efficient than ladles for handling raw materials and products in course of manufacture, so automatic machinery has been used to advantage and its additional use and improved types thereof will continue to make production more efficient.

Physical Chemistry in Soap Making

As to the actual manufacture of soap, it would be difficult to beat the quality of material turned out by the settled soap process when properly carried out. This process gives two distinct phases or layers, the upper of which may be made remarkably free from excess alkali and other impurities. The only drawback to this process is the time it takes and the fact that approximately 20 per cent of the soap produced goes into the lower phase, or nigre, along with excess alkali and impurities, and this necessitates the reworking of an appreciable amount of the product.

If the settled soap process is to be improved, rather than replaced, it will have to come through a study of the physical chemical conditions that will promote the complete formation of the two distinct phases and their rapid separation. A low viscosity in this change is a desideratum, whether it is obtained by changes in composition or by a more perfect temperature control. The composition of the phases is influenced by the mutual solubilities of all the substances present and these are influenced by the temperature, so, as a matter of fact, a control of viscosity and consequently more rapid and more complete separation of the phases can be obtained only by a proper control of the composition of the whole mass and the temperature.

A number of years ago I found that the soap phases could be completely separated in centrifugal machines and I aimed to run them through a suitable machine to effect at once the continuous separation that has always required a considerable amount of time. So far I have not seen the machine that would compete with gravity settling, considering together effectiveness, capacity and cost.

It is possible to make good soap without the formation of nigre, but it is more difficult to get uniformity and high quality and is more expensive for labor and control than the settled soap process.

Other Lines for Improvement

The economical production of soap requires a study of the selection, treatment and apportioning of raw materials, fats, oils and alkalis, and their control through the stages of manufacture up to the production of finished soap and glycerine. There are few places where at least some improvements are not possible all along the line.

In the manufacture of toilet soap a big advance was brought about by the rapid, continuous, clean drying made possible by the Cressoniers driers and later by the several other driers using the same principles of chilling the soap on cooled rolls and sending the ribbons over endless woven wire belts through a drying chamber. An automatic or other suitable simple control of the amount of drying or percentage of water in the finished soap would add to quality and efficiency.

Soap powders are being produced on a large scale and quick and efficient methods for their manufacture are being worked out and adopted.

Jersey City, N. J.

How Process Equipment Aids Production Efficiency —Pointers for the Purchaser of Equipment

By O. S. Sleeper
President, O. S. Sleeper & Co., Inc.

IT IS essential, in all manufacturing lines, to increase production efficiency and reduce manufacturing costs. This end is largely achieved through judicious equipment purchase and efficient operation of the equipment purchased.

The tendency of the users of equipment is to buy on price or to find used material that will do. In most cases both these methods result in unsatisfactory operation. Only apparatus containing all the elements necessary for the manufacture of the product and constructed of material best suited for the purpose should be considered; and adaptability rather than first cost should be the main consideration.

If this course is followed, satisfaction should result. This satisfaction will extend beyond the purchase and installation of the equipment. It will please the workman, thus making his work more tolerable, resulting in increased production, better quality of product and more satisfied workers.

It is often a question with the manufacturer of chemicals as to what apparatus he should use; and in the effort to find what he requires, or can use, he peruses the advertisements. With few exceptions, this is his

only method of locating the manufacturer of equipment, and is the proper method. However, the advertisement is generally brief, and perhaps does not contain the information he requires.

It is necessary, then, that he write to the equipment firm for this information and for prices. He sends his inquiry, which is also brief; and, in reply, he receives a quotation and a request for additional information. This is not satisfactory, as the quotation does not cover the requirements, and further delay is caused.

These delays and unsatisfactory methods may be eliminated to a large extent and better and more satisfactory equipment furnished if the secretiveness which surrounds most chemical plants be set aside and confidence placed in the equipment manufacturer. If the chemical plant furnishes designs, then the reliable manufacturer will hold such designs in confidence. Often the standard equipment will do or it may be modified to suit specific requirements, and such modifications could be made by the builder better and cheaper if he were informed of what is necessary. It must be kept in mind that an advertisement cannot convey the complete information necessary for the final selection of equipment, as it does not explain all details of each machine.

In a majority of cases it is important to give the equipment manufacturer full information regarding the material to be handled to enable him to select from his standard designs or to make the special design required for the purpose.

This is not meant as a criticism of present methods, but is intended to convey the importance of closer relations and a greater degree of confidence between the manufacturer and user for the best interests of all concerned.

Buffalo, N. Y.

Improvements for Production Efficiency in the Glue Industry

By Jerome Alexander

In common with other industries, increased efficiency in glue manufacture must be along lines which may be classified under two general heads: Avoidance of waste and production of an improved product. Under the first of these come power plant and fuel economies, savings in freight and handling charges, etc., which are not peculiar to the glue industry.

Steps in Process Where Improvements Are Possible

Following the raw material step by step through the process, the following points should be considered in connection wih the production of an improved product.

Receiving and Preparing Glue Stock. Avoid unnecessary rehandling and save labor by utilizing mechanical appliances. Shredded hide and crushed bone or osseine may be pumped with water or handled by bucket conveyors instead of by the manual methods still employed in many plants. By bringing the limes to the proper H-ion concentration with caustic soda, the time of liming may be shortened without injury to the stock.

Washing Glue Stock. An improvement over the old cone and paddle wheel washers, which have been in use for years, seems called for. Circulation of the stock by a screw conveyor through a trough against a stream of water seems to be an interesting possibility, for the washing would proceed continuously rather than on the batch principle. A new German washer having two vertical shafts with arms is emptied by a bucket elevator.

Boiling. Most factories depend mainly upon convection to distribute the heat, and this generally results in local overheating, besides protracting the process. The more general introduction of circulating pumps, used in some plants, should be advantageous.

Evaporation. The vacuum evaporator is so highly perfected today that lack of capital or insufficient capacity is the only excuse for not having an efficient unit—a good illustration of what scientific engineering practice can do for an industry. However, priming must be avoided or glue will be lost with the condensate.

Chilling, Cutting, Spreading and Drying. Although for years the attempt has been made to combine these into one operation, none of the older systems proposed, even that of Peter Cooper Hewitt, has survived. Most promising is the Kind apparatus, which is said to chill, cut and spread an evaporated glue liquor within about 20 minutes after its receipt. The apparatus is automatic and effects a great saving in time and labor.

Speedy drying of glue is important, otherwise an expensively large dry room is necessary to avoid a "neck" in the process. The netstacks should fit the room closely, otherwise the heated air will get by without taking its full quota of moisture.

The Ruf system, recently introduced in Germany, delivers a concentrated glue froth to a hooded steam-heated revolving drum over which a draft of air is forced. The finished glue in powder form is scraped off by a knife. Vacuum drum driers are also used to produce glue powder, but this form of product is objected to by some consumers, without good reason in many cases. Much trouble and expense can be saved by consulting firms or engineers who have had actual experience in drying glue.

Byproducts. Some plants do not use or give proper attention to catchbasins and lose grease-containing material. Others again lose grease in their fertilizer tankage, where it is rather a detriment. For some uses grease improves glue, and if the market for glue is higher, some grease may profitably be left in the glue.

Producing Better Glue

The basic principle is to get the glue dissolved out of the stock and dry it as quickly as possible and with minimum exposure to heat, both in point of time and degree, and without undesirable agitation. The observance of the principle requires attention all along the line—proper plumping of the stock to insure speedy solution; boiling at as low a temperature as possible, yet balancing temperature against time of boiling; evaporating without overheating; then chilling quickly and drying to avoid bacterial attack. Since the importance of the effective reaction of glue (hydrogen-ion concentration or p_H value) has been shown to affect its viscosity and water-absorbing power vitally, this should be more carefully adjusted than has been done in the past. Iso-electric gelatine which absorbs only 7 or 8 parts of water may absorb up to 40 parts at a p_H of about 3, though this degree of acidity is excessive.

All told, it pays to use the best apparatus and employ the best brains. But there is no substitute for common business sense. It is not profitable to produce an improved product at a cost which exceeds the added selling value.

Ridgefield, Conn.

More Efficient Distribution for the Products of the Chemical and Allied Industries

Sales Executives and Others Comment Frankly on the Marketing Problems of Their Businesses and Offer to Support Increased Production Efficiency With Better Directed and More Intelligent Selling Methods

RECORDED among the findings of the Joint Commission on Agricultural Inquiry is the conclusion that in the case of many of the basic commodities of commerce more than half of the ultimate cost to the consumer is directly chargeable to the agencies of distribution. This is not a particularly novel discovery in itself, but it hints at a state of affairs to which industry can well give serious thought. If the gap between producer and consumer is allowed to absorb 50 per cent of a commodity's cost, we can very profitably forget production for a moment and give attention to the disproportionate cost of distribution.

To say that a parallel condition obtains in the chemical and chemically controlled industries, however, is not to speak the truth. No such spread exists in the case of these basic materials, sold from industry to industry rather than from industry to the individual consumer. Nevertheless these industries offer much to justify a serious consideration of their selling problems. Many of the mainly chemical industries are comparatively young and during the period of their rapid growth every effort was made to solve the problems of production. The same intensive and sympathetic study which other industries have given to distribution has often been neglected in the zealous endeavor to lower the costs of production.

In the dozen or so brief messages that follow it is evident that our technical executives are already solving the marketing problems of their industries. Treatment is given such varied subjects as technical service, direct selling, open prices, market stabilization, standard specifications, elimination of excess varieties, the tariff and transportation. Improvement along most of these lines means lower costs to the consumer, whether he purchases chemicals directly or the products in which they are used. Industry as a whole will profit when increased production efficiency is supported by well-directed and more intelligent distribution.

A Higher Plane of Chemical Salesmanship

By Burton T. Bush

President, Salesmen's Association of the American Chemical Industry; President, Antoine Chiris Co.

NOW that the fine chemical industry has taken root on American soil the problem of closer co-operation between the source of production and the ultimate consumer is going to be solved to the advantage of both. Research will cease to find sympathy alone with the chemist; research will be carried clear through to the ultimate user of the chemicals produced. The American manufacturer must now recognize this as an integral part of the chemical business in America and must begin to arrange for it in his yearly budget.

I am a thorough believer in the fact that one day a chemical salesman's value will be based on his knowledge of chemistry, that he will step to his place as a possible counselor for the trade consuming his products, and his ultimate value will be in his ability to suggest. Having, as he will, his own personality and individual way of obtaining a result, he will be fearless to allow his objective to be known, because the objective will cease to be a secret of the concern he represents.

America takes hold of the chemical industry at a time after every marketing method is apparently known and has been tried. To my mind there is but one great method left, and that is to take the secretiveness and mythology out of chemistry, giving the American consumer the benefits of the knowlege of the producer, all of which will naturally result in a better co-operation.

In conclusion, I have no hesitancy in stating that the essential oil, aromatic and fine chemical industry of the United States will demand that open scientific research be employed in every phase of its work. Then quality will be known and appreciated and likewise it will be demanded, and the final proof of success of this industry will depend on how well the chemical manufacturer keeps the public in his confidence.

New York City.

Intelligent Distribution of Crude Coal-Tar Products

By David W. Jayne

Jayne & Sidebottom, Inc.

INCREASED efficiency through more intelligent distribution can certainly be obtained in the case of the so-called coal-tar crudes. This term has been very freely applied to the directly recovered products from coal tar in refined condition suitable for the manufacture of such products as dye intermediates. The manufacturing processes permit of considerable variation in the purity of the finished products, so undoubtedly what is most needed is an accurate knowledge of the requirements of the consumer as to quality and the corresponding price limitations.

An intelligent understanding of this question involves the use of experienced and "technically intelligent" salesmen; it also demands frankness on the part of the buyer of these products. It has been claimed by many buyers that the refined coal-tar products, such as benzene, toluene and naphthalene, are not as pure as those supplied to the German manufacturers, and this is probably true, but the problem is to increase the purity without unwarrantably increasing the price. Just what is needed in the line of quality specifications can be determined only by frank and intelligent discussion between buyer and seller, coupled with an equally frank understanding of the additional costs of such improvements in quality and the possible increased value to the buyer.

Prices are sufficiently open so that this, I believe, is not an essential question in the sale of this class of

products. Buyers and sellers pretty generally know at what prices others are buying and selling. These products have not been and are not sold on a basis of all the salesmen can get for them, but rather on a fixed price-list basis.

The production department must also have confidence in the accuracy of the reports of the salesmen. Too often salesmen recommend changes in quality or price which the production man recognizes as unattainable and which were "put over" on the salesman by some ambitious buyer. If the salesmen are men of technical training with experience and are in the confidence and in touch with the factory, then production efficiency can be increased by the intelligent exchange of information between sales and production departments.

All this can be summarized in a few words about as follows: Confidence and co-operation between the sales and production departments of both buyer and seller mean increased efficiency of distribution as well as production.

New York City.

Autumn Prospects in the Dye Industry Are a Matter of Conjecture

By Giles Low
Sales Manager, Newport Chemical Works, Inc.

It is no easy task to make an estimate of business conditions for the fall in the dye and coal-tar chemical industries. True, they must be good or bad; but definitely to say which precludes a foresight into the decisions of that inexorable body at Washington—the Sixty-seventh Congress. Not only for fall, but indeed for our whole future, does the making of business conditions lie now with our government, and to indicate to it what is right is at present our most responsible task.

The United States owes a debt to its chemists, who have striven diligently during the last two hard years, and to the financiers who have backed them. Moreover, she owes to our citizens the insurance of the safe and prosperous future which only a substantial domestic chemical industry can bring.

Protection of an Essential Industry

So much has already been said and written of what the chemist has done for us as a nation in the way of inventing and manufacturing medicines and drugs, as well as dyes and foods—necessities normally unappreciated—to say nothing of explosives in times of war, that a repetition of the vital importance of the industry is almost unnecessary here. Whether we shall maintain the protection and enjoy the fruits that our new chemical supremacy has given us, or humbly give them up to our erstwhile enemy, is today in the hands of Congress.

If the outcome again puts us at the mercy of Germany, business will be bad in more ways than one and for more than those now interested. If, on the other hand, some adequate protection is granted, a condition even somewhat better than normalcy will obtain. Our universities will not have educated chemists in vain; our financiers will not have wasted their vast sums invested in the industry, and our most promising infant in the industrial field will grow to be our most useful big brother.

Passaic, N. J.

Straight Talk Needed Between the Oil Producer and Consumer

By Otto Eisenschiml
Manager, Scientific Oil Compounding Co.

The problem of marketing special oils is one that is more inherent in the buyer than in the seller. These oils are made to fill a special want not covered by standard grades of oil on the market, and one would expect to have possible customers talk frankly and straight to the point about their troubles. Unfortunately, this is far from being so. They come to the manufacturer like a sick man to a doctor, but what they want is not a cure for special ailments at the doctor's discretion, but a special 10-grain white pill to come in a blue box with a yellow label. Only a few days ago a manufacturer was asked to supply a certain cold-pressed vegetable oil. Being fairly honest, he refused even to quote on a commodity existing only in the minds of some buyers and in the mouths of imaginative salesmen. During the discussion that followed the manufacturer found that all he had to do was to supply a fairly clear oil of low acid value and good drying power—the cold-pressing having been lost in the shuffle.

Specifications for special oils, printed and otherwise, are full of arbitrary and unnecessary points, such as the one mentioned. The psychology of the buyer seems to be that the more trouble and expense he can put on the manufacturer the better the goods will be for himself, and he therefore tries to prescribe what should be done rather than what should be accomplished. Almost all specifications on linseed oil demand that it be aged by tanking. What is really wanted is a clear oil, and of all the methods possible to get this result, such as filtration, centrifugal machines, etc., tanking is the most uncertain and most expensive of all. And yet we have constantly to contend with such people and others who demand that a varnish be thinned with turpentine when they mean that they want a high flash point, that a paint oil contain no rosin when they mean that it should not liver with white lead, and so on *ad infinitum*.

I do not know whether or not the special oil field is different in this respect from other fields of endeavor. But the fact remains that, just as straight line is always the shortest distance between two points, so a straight talk between producer and consumer is the best basis for all specifications.

Chicago, Ill.

Knowing the Requirements of the Consumer of Vegetable Oils

By Henry G. Perry
Sales Manager, Cook & Swan Co., Inc.

We are all interested in increased production efficiency. The theme is well chosen. Among other things, it would imply power on the part of the distributor to retain a clientèle secured by strength of salesmanship. The day has gone by when we might have been able to give a customer something "nearly as good" as that which he requires. The efficient method of distribution today is to sell your article on a guarantee of satisfaction, whether it be oils and greases for technical trades or for the refinery. Salesmanship, in itself, is a part of the business which cannot be treated lightly. But salesmanship commences only when the product is salable. In other words, the quality of a product must stand before the art of selling. The man

with the best product today will get the order. The consumer's troubles should be the troubles of the supplier, and the supplier should base his products on the requirements of the consumer. We must forget the product which was nearly as good and put in its place the product with which the consumer can register complete satisfaction. A house with a hundred satisfied regular clients is better than one with five hundred spasmodic inquirers.

New York City.

Eliminating the "Fly-by-Nights" in the Chemical Industry

BY MILTON KUTZ

Manager of Sales, The Roessler & Hasslacher Chemical Co.

AS IS DOUBTLESS the experience of others in the chemical industry, the firm with which the writer is connected frequently finds itself underbid by importers and other firms whom we would like to characterize as "fly-by-nights" and who having had only a few years' experience, either do not realize or do not care whether their goods are suitable or meet the specifications of the particular consumer or industry for which they are intended.

On the other hand, the service given to this trade by the older chemical houses is the result of many years of experience in production and actual use of the products they produced. The knowledge derived therefrom is gladly passed on to their customers. However, no legitimate enterprise can continue to maintain a large sales organization and give service unless there is some margin of profit. A mighty endeavor to sell, which has become prevalent in many branches of the chemical industry, has been the cause of the receiverships in bankruptcy which have been occurring so frequently. The "return to normalcy" phrase has become something of a joke. It will never be accomplished until some people thorougly learn their lesson that overhead must be considered in their selling price. Not until more chemical firms do this will a real stabilization of the market be attained.

New York City.

Resale, Turnover and Volume—The Problems of the Paint Industry

BY H. D. WHITTLESEY

Vice-President and Managing Director of Sales, The Sherwin-Williams Co.

THE three words resale, turnover and volume sound the keynote of the endeavor we must all put forth today.

What's the answer?

A keener sales activity. If our products are better than the other fellow's, then we have a right to expect corresponding increases in volume. It behooves us to present our proposition attractively, or the other fellow will outsell us.

We must have better kept plants, better production, better looking products, better packing and shipping, fewer mistakes down the line.

Warehouses must be well located and efficiently serving the territories they are intended to serve.

Salesmen must give a type of service never before required to such an extent. There must be less duplication. There must be more emphasis on the goods and what they will do; clerks must be better educated to sell—they must know the whys and wherefores of quality, ingredients, purposes, etc. Price cuts little figure if the resale of the product is in the right hands. Put a Cadillac in poor dealer hands and you will immediately boost the sale of Lincolns.

CREATIVE SALESMANSHIP IS ESSENTIAL

New avenues of sale must be developed. We cannot keep taking business from our competitor without building new business and new markets. Creative salesmanship is the need of the hour. It must be specific, educational and thorough. So must the advertising of today. One cannot continue advertising for "general results" or his results will be very general. He must talk his product in terms of what it will do, how it will fit into the scheme of things, and it must be told in a human, readable way. Only a few people are relatively interested in mechanics; masses of people are interested in the everyday stories of life and living.

The sales department must know who is buying its goods; who used to buy and stopped; why did they stop; what new trade is being added to the books; what dealers are being added; what dealers are being dropped; how is the volume changing geographically and why; what important towns and territories are undermanned or not manned at all; what is each territory producing per man per day per dollar of cost; what dealers are going ahead and what dealers are standing still and why; is the salesman taking orders or is he helping to resell for the dealer to make way for more goods; what classes of trade are being called on daily and what classes are being neglected; is too much time being spent on unproductive things.

We have a man-sized job ahead, but the victory will go to those who produce well, distribute wisely, turn over their investment frequently, sell hard and render a service to the buying public.

Cleveland, Ohio.

Marketing and Distribution Problems of the Alcohol and Related Chemical Industries

BY B. R. TUNISON

Manager of New York Sales, U. S. Industrial Chemical Co.

MARKETING and distribution problems in the alcohol and related chemical industries are complicated primarily because of the nature of the principal raw material in these industries—namely, alcohol. This material is subject to very strict regulation and control. Since the passage of the national prohibition act, the regulations and red tape have become so great as to interfere seriously with business using alcohol for industrial purposes. Not only have the users been subject to various laws, rules and regulations, as well as arbitrary rulings (not based on law or regulation) on the part of federal officers, but the manufacturers of alcohol have been unable to develop and extend their business in accordance with the law which provides for "an ample supply of alcohol and promote its use in scientific research and in the development of fuel, dye and other lawful industries."

One of the greatest problems facing the fine organic chemical manufacturers in the United States at the present time is that of technical service. Many phases of these industries are new to the United States and the utilization and development of the products call for definite technical information and advice. In the first place, it is difficult to obtain men who are able to render such technical service, and in the second place, when

such advice and service are given, it is not always easy to convince the user that the product and method of utilization indicated are to his best advantage. This inertia is due largely to the operation of some industries by rule-of-thumb methods rather than modern technical control.

Probably the most depressing factor and the one interfering most with the proper development of our American chemical industries at the present time is the tariff situation. It is impossible to develop sales, distribution, production or anything connected with a healthy chemical business when the manufacturers do not know from one moment to the next whether they are to be protected in their efforts or whether they will be subject to the ruthless competition which is the inevitable result of not keeping out of the country products which will be sold at prices far less than the cost of production by American manufacturers.

A factor which is bothering a number of manufacturers in these industries is the fact that during the war a capacity for the production of certain products was developed which is in excess of the normal consumption during peace times. Strenuous efforts are being made to develop new markets for these products in order that production can be increased to the approximate capacity so that a moderate cost of production can be maintained. This puts tremendous pressure on marketing and distribution activities in order to reduce the cost to a satisfactory level.

Although many of our American chemical industries are passing through very trying times, there is no question that they will be successful and able to compete in any world market if they are given sufficient time and proper encouragement and protection. Chemical industries such as we are building in the United States at present cannot be completed in the space of a few months. Therefore proper protection should be given them until by development products are improved and costs are reduced, so that these industries may succeed.

New York City.

The Ferro-Alloy Situation Beclouded by the Tariff

By J. W. Bradin
Vice-President, Dana & Co.

The problems connected with the marketing of ferro-alloys are rather difficult to gage, due chiefly to the proposed new tariff rates and in part to the market position of ores. Ferromanganese will undoubtedly sell at a much higher price than today if the high tariff duties on ore and metal are passed. Already this is apparent by the willingness of buyers to pay a premium for foreign ore due to arrive shortly. We believe further that the expected increase in price of ferromanganese will stimulate the sale of spiegeleisen.

The price of ferrosilicon will probably not rise in step with the higher protective rates, due to the largely increased manufacturing capacity for this alloy, which potentially at least should act as a restraint to any substantial increase in price. In spite of a much higher tariff on ferrotungsten, we expect only a gradual increase in price, due to the very large spot supply of ore which is hanging over the market. On the other hand, ore can be bought today below the cost of mining, a condition which is not likely to continue. Marked changes in price for either ferrochromium or ferrovanadium are not expected in the immediate future.

New York City.

Distribution of Chemicals in Foreign Markets

By C. R. DeLong
Chief, Chemical Division,
Bureau of Foreign and Domestic Commerce

The question of intelligent and effective distribution of American chemical products in foreign countries is one that is of deep interest to the Chemical Division of the Bureau of Foreign and Domestic Commerce. The marketing of chemicals outside of the United States presents problems of a character differing from those met with in domestic markets. It is only by a close and careful study of conditions existing in the markets of each particular country that the most efficient distribution will be attained. I believe that the recently created Chemical Division will be able, through the various agencies at the disposal of the Department of Commerce, to give material assistance to the domestic chemical industry in solving these export problems.

The department, by means of its commercial attachés, trade commissioners and the co-operation of the consular service of the Department of State, can place at the disposal of American chemical concerns interested in the development of foreign markets information as to the extent of markets, the competition that is likely to be met, agencies that are qualified to handle the particular products, customs duties and commercial regulations governing the sale of special commodities.

Representatives of the department in foreign countries are constantly reporting opportunities and inquiries for the sale of American goods. These "trade opportunities" are brought to the attention of domestic firms known to the department as being interested in the development of foreign trade. In this connection a list of American firms known as the "Exporters' Index" is maintained. Only concerns which are American-owned and interested primarily in the promotion and sale of American goods are included in this list. These firms receive confidential information as to financial references, commercial reputation of the foreign firm, and other comments pertinent to the trade opportunites in foreign countries.

Dependable Trade Statistics

Another factor essential to the intelligent distribution of chemicals in foreign markets is accurate and detailed statistical information on the trade of various countries, so as to determine what share of this trade is being obtained by the United States. In order to make such statistics available at the earliest possible date mimeographed monthly statements of exports of important commodities showing the countries of destination are sent to interested firms. These special reports thus make this statistical information available considerably ahead of their publication in the Monthly Summary of Commerce and Navigation.

Detailed studies are made periodically of world markets for groups of commodities or on the conditions surrounding the markets of a particular country. These published reports can be obtained at a small expense as compared with the valuable information which they contain.

The Chemical Division hopes to serve effectively the American chemical industry in the development of foreign markets and to aid in the efficient distribution of its products in these markets by placing such information in the hands of interested American firms at

the earliest date and in the most concise form. I believe that if the chemical manufacturer will avail himself of the services of the Chemical Division the distribution of chemicals in foreign countries will be more efficient and there will result less waste in time and money. With complete information at hand, the sale of American chemicals in foreign markets should be no more difficult than the marketing of the same products in domestic markets. The Chemical Division is always ready to receive and seeks the suggestions of domestic firms as to the nature of the information which will be of the greatest aid in marketing their products in countries outside of the United States.

Washington, D. C.

The Alkali Market From the Jobber's Viewpoint

By W. F. George

President, W. F. George Chemicals, Inc.

THE SITUATION in the alkali market, particulary in the less than carload jobbing trade, continues to be very unsettled, as it has been for many months past. This seems due principally to two reasons: first, the general business condition, which makes it practically impossible for the small consumers to predict intelligently what their requirements will be over a given period; second, the great variety of prices quoted by the various factors in the alkali market on this kind of trade.

The open price policy advocated by many in various lines of business would go a long way toward stabilizing the alkali market if it were conscientiously adhered to by all. However, if a pretended open price policy is combined with underhanded cut-throat competition, no benefit will be derived, but on the contrary a situation already bad will become worse.

If this market could be stabilized at some fair level, the consumers would gradually gain confidence in their sources of supply and would feel more inclined to contract ahead for their requirements instead of buying from hand to mouth as they have been doing up to the present time. This would result in lower selling costs, more efficient distribution and an ultimate saving to all concerned.

New York City.

Stabilizing Profits in the Petroleum Industry by Predetermining Market Conditions

By Joseph E. Pogue

Consulting Engineer

DURING the past 18 months the problem of stabilizing earnings in the petroleum industry has received wide attention. The general feeling in oil circles has been that the extreme fluctuations characteristic of this industry constituted a serious liability and that concerted effort should be made to avoid the tremendous losses arising from this source. Unfortunately, however, the only noteworthy attempt so far to better conditions—the policy of price stabilization started late last year by the major purchasers of crude petroleum—was abandoned last month with drastic price slashing and must accordingly be adjudged a failure. Thus today the petroleum industry is in a chaotic condition, apparently further from achieving stabilization than at any time in its history. Evidently some new methods of attack are needed.

Perhaps we can see what these new methods must be if we analyze the fundamental causes of this instability. The underlying causes are two in number: fluctuations in price and variations in demand. Both of these conditions are primarily beyond the control of the petroleum industry itself and thus we reach our first conclusion; namely, that the basic cause of instability in the petroleum industry is external and arises from the instability of price and demand in the commodity markets upon which the petroleum industry is dependent.

The losses from these fluctuations in prices and demands are tremendous and exert a disastrous effect upon earnings and profits. For example, one of the largest and most successful refining companies in the East in 1921 showed gross earnings of only $105,000,000 as compared with $169,000,000 in 1920, due to a sudden recession in price and demand; the effect upon net profits was even more destructive, these falling from $10,000,000 in 1920 to a loss of $5,000,000 in 1921. Another very successful company, this one both a producer and a refiner, operating in the Gulf coast, suffered a decline in gross earnings from 1920 to 1921 of $32,000,000, and the net profits of this company were $19,000,000 less in 1921 than in 1920. These two examples are not exceptional; they represent, on the contrary, two of the best and most conservatively managed oil companies in the United States.

The Crux of the Matter

The petroleum industry, in common with all other industries, has devoted no end of effort to increasing its operating efficiency by perfecting its control of internal conditions. The outstanding and untried opportunity lies in the direction of external conditions—conditions that are responsible for the loss of perhaps three dollars for every dollar lost through operating inefficiency. But external conditions, as we have noted, are not primarily subject to control by operating units of an industry. True; but operations can be adjusted so as to fit external conditions, in so far as the latter are not subject to direct control, and this brings us to the crux of the matter: External conditions—that is to say, prices and demands—should be charted ahead with the same care that internal conditions are analyzed and projected, and when this is done adequately the oil business can be kept on the track, even though the track itself cannot be entirely straightened.

Can prices and demands be predetermined scientifically? The answer, with due qualifications, is yes, but not easily nor incidentally. Not until the opportunity existing is recognized and proper effort is accorded it. No, in fact, until the oil industry gets up to date in this respect and does, as a matter of course, what enterprising concerns in many other lines are doing. Then the results, though far from infallible, may be expected to raise substantially the average of accuracy with which plans can be laid and production schedules guided.

The way is open. There is no need for the best companies in the oil business to have suffered the losses they did in 1921. There is no need for the best companies in the oil business to alternate between overproduction and underproduction, to swing perennially between a feast and a famine. The answer lies in the market place; the way to the answer is through the employment of a new tool—the analysis and use of external conditions, the predetermining of price and demand.

New York City.

The Fundamental Requirements of Salesmanship in the Heavy Chemical Industry

By P. S. Tilden
Sales Manager, Lithopone, Pigments and Heavy Chemical Division.
E. I. du Pont de Nemours & Co., Inc.

LONG EXPERIENCE in the marketing of heavy chemicals has taught that each day brings its own problems, each its own lessons. Those who persist that there is a minimum of technicality in the conduct of the business suffer from the very symptoms which they claim do not exist.

A chemical salesman has nothing but his card and his personality to present to the customer. Unlike the man with a line of samples to submit and who, irrespective of personal appearances or attributes, may make sales based on the quality and price of his products, as indicated by those samples, the chemical salesman must, by his own individual force and enthusiasm, so impress his prospective customer that he becomes interested in company and products represented to him.

I have been asked whether technical knowledge helps the salesman and to what extent. It is axiomatic that knowledge of the proper kind always helps, but the extent to which it helps is governed, in my estimation, by the manner in which it is used.

Three Types of Chemical Buyers

Chemical buyers are of many types and kinds: We have the trained chemical buyer who is a part of his business, and knows its every detail from the ground up; we have the executive type who orders on requisition from his factory, with a limited degree of technical knowledge, and we have the purchasing agent, pure and simple, who will frankly confess to you that he has a "smattering" of all the products he purchases, but knows the details of the manufacture of but few, if any.

Now all these types are purchasing the same class of chemicals, highly technical in their character. The salesman, therefore, if with this technical chemical knowledge, must use great diplomacy in the manner in which he expounds his learning to the various types of buyers, or he is very likely to offend.

I have always claimed that there are three fundamentals that a chemical salesman should have at his command—viz., what his goods were made from, how they were made and what they were used for—but special care should always be used in recommending formulas, unless one is quite sure of his ground.

Each day brings the chemical salesman something of new interest—there are constantly being developed new uses for his products, so he must be wide awake and alert.

Sound Advice for the Salesman

In the days of Dana, as editor of the New York *Sun*, he had hung in his office the motto "Keep Your Eyes and Ears Open!" The chemical salesman could, with profit, bear this legend in mind. His must be an enthusiasm born of a love for his business, he must be able to convey this enthusiasm to others, he must make friends—and he must keep them. He should not be too intimate with his customers, but he must keep their respect, because his is the burden to keep them continual good-will customers of the house he represents, and he can do this, whether he can or cannot give you the formula for sulphuric acid; but if he knows it, he is so much better off.

In other words, no hard and fast rule can govern—it is the individual who can make or break his career in the heavy chemical business.

Finally, a word as to open prices. It must appeal to all that intelligent competition is far preferable to that of a ruinous character, and so if open prices will bring about the former condition, certainly they are to be desired.

Newark, N. J.

The Contract Evil in the Marketing of Steel Products

By B. E. V. Luty

FOR years the marketing of finished steel products has stood in need of one great reform, abolition of the "requirement," "option," "jug-handled" or "accordeon" contract. The practice of making such contracts was established a quarter century or more ago, the late Andrew Carnegie being reputed to have been the originator of the system. The object was to tie up a consumer, so that if the consumer had requirements the mill making the contract would get the business. If he did not, the mill would lose nothing.

The principle may have been good in certain cases, but the practice was badly overdone. Mills got into the habit of overselling, on paper, in an effort to insure full operation, while buyers in turn were moved to overbuy, since when business was good, mills could not make shipments at the full contract rate.

The usual contract of this style is not enforceable. An improvement made before the war gave the seller power to cancel unspecified monthly quotas. Mills sometimes advanced asking prices simply to induce specifying on the old contracts, then making contracts for a fresh period, advancing prices again, and so on until the market became top-heavy, thus insuring an eventual break in prices.

Since the war-time control of the steel market by the government the making of these blanket or requirement contracts has not been altogether as prevalent as formerly, one deterrent factor being uncertainty as to costs. The practice should be entirely abolished, except perhaps as to contracts for relatively short periods. A definite tonnage should be bought and sold, the mill should deliver on time and the buyer should accept and pay.

Definite extras should be charged for small lots of a size or section, to cover extra cost of production. By the establishment of such extras buyers would be moved to specify larger individual quantities at a time, carrying stocks of the sizes they require in small quantities only. When steel is scarce mills charge extra for mixed specifications, but as soon as orders become scarce they forego even the most reasonable charges.

Pittsburgh, Pa.

Taxing the Raw Materials of the Soap Industry

By Martin H. Ittner
Colgate & Co.

IT MAY not be out of place to say here that very large and exorbitant customs duties are now proposed for the first time on fats and oils that do not compete to any extent with our own production of fats and oils, which are exported by us in enormous quantities. This will not help the producer of American fats and oils and will necessarily increase the cost and selling price of soap.

Jersey City, N. J.

Production, Consumption and Prices

The Trend of Prices for the Principal Commodities in the Chemical Market Is Briefly Reviewed and Statistical Summaries Are Given for the Volume and Value of Manufacture, Imports and Exports

JUST as 1921 was a year of reaction from the excesses of the preceding year, so 1922 has been characterized by a slow and gradual recovery. Much of the damage incurred in the rigorous processes of deflation and liquidation has been repaired and industry in general has adjusted itself to the changed conditions of competition. All along the line there has been consistent improvement. The increased volume of production, wider distribution and growing consumption of commodities, easier conditions in the money market, higher security values, fewer business failures and better price adjustments—in fact all of these basic indexes of business activity point definitely to the fact that the corner has been turned and business is on the upward grade.

The chemical industry, somewhat slower than others to feel the effect of depression, has not responded quite as quickly to the stimulus of better times. If we are to judge from price trends, the year May, 1920, to May, 1921, covers the span of the most severe deflation. From May, 1921, to June, 1922, was given over to the uncertain process of readjustment, while the first 5 months of the current year witnessed a gradual and consistent recovery. Since last May, however, prices have shown the effect of the usual seasonal lull. It is perhaps significant to note that, as measured by *Chemical & Metallurgical Engineering's* weighted index of chemical prices, May was the high month for 1920, the low month for 1921, and again the high month for 1922.

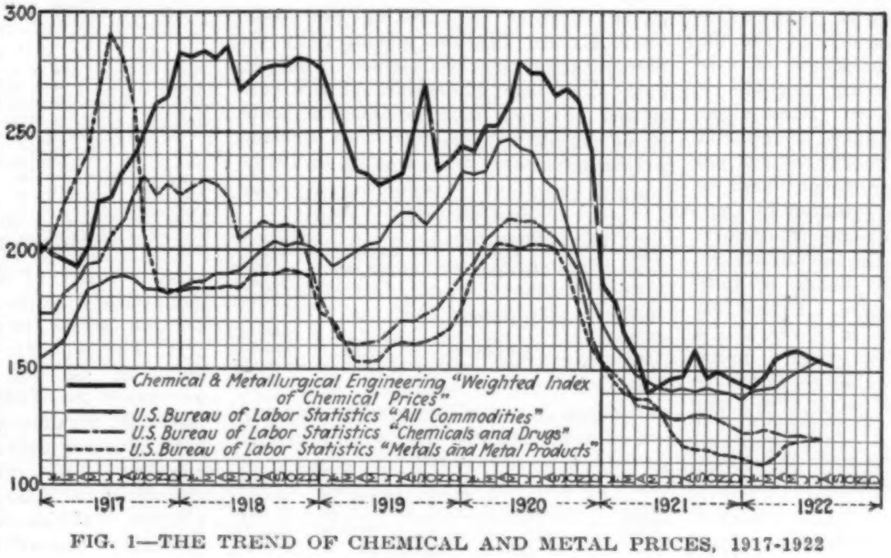

FIG. 1—THE TREND OF CHEMICAL AND METAL PRICES, 1917-1922

TABLE I—CHEMICAL AND METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES, 1917-1922

(Base = 100 for 1913–1914)

	1917	1918	1919	1920	1921	1922
Jan.	198	281	262	242	181	144
Feb.	195	285	250	252	166	148
Mar.	191	281	233	252	157	156
Apr.	207	286	231	261	140	158
May	222	267	227	279	143	159
June	222	272	229	274	147	157
July	233	277	231	274	148	156
Aug.	240	278	251	264	158	152
Sept.	252	278	272	267	147	...
Oct.	264	280	233	263	151	...
Nov.	265	279	239	240	147	...
Dec.	283	277	245	189	145	...
Averages	212	279	242	255	152	154

This index number, whose course since 1917 may be found in Table I and is also shown graphically in the accompanying figure, was compiled to assist our readers in following the week-to-week trend in the chemical market. It is based on twenty-five commodities so selected as to represent qualitatively and quantitatively the principal branches of the chemical industry. The average wholesale prices for these commodities in the New York market were weighted on the basis of the total production plus imports in 1919, and finally these figures were compared with and expressed in terms of a pre-war base. This base of 100 represented the average monthly prices for the year July 1, 1913, to June 30, 1914.

During the 5½ years included in this compilation the chemical market has followed an unusually interesting course. This magazine's index number rose from 191 in March, 1917, to 286 in April, 1918. Then followed a period of high prices, ending with a decline, which began at the time of the armistice and extended throughout the first 6 months of 1920. The post-war boom of 1920 had its effect about this time and prices again rose to 1918 levels. This was followed by the precipitous fall of prices during 1920, when the index number dropped from 263 in October, 1920, to 140 in May, 1921. The remainder of 1921 saw a number of minor fluctuations. During the first 5 months of the present year a consistent improvement was to be noted, but June, July and August have again shown slight declines. Prices are still considerably above the level at the beginning of the year, however, and the average for the first 8 months of 1922 is 154, as compared with 152 for 1921 and 255 for 1920.

THE TREND OF PRODUCTION

The increasing volume of manufacture during the current year is shown in a striking manner by the statistics published monthly in the "Trend of Business Movements" section of the *Survey of Current Business*. This publication of the Department of Commerce is prepared by the co-operation of the Census Bureau and the Bureaus of Standards and Foreign and Domestic Commerce. Selected figures for certain of the more important of the chemical and allied industries are shown in Table II. From the last column of this tabulation it will be noted that with the exception of beehive coke, cottonseed and linseed oils and electrolytic copper, all of these commodities show marked increases over the corresponding periods in 1921. These range between 1.1 per cent in the case of chemical wood pulp to a gain of 112.4 per cent for the consumption of crude rubber by the tire manufacturers. The wood chemical industry,

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

This week 149.80
Last week 150.92

Included in this index are acetic, citric, hydrochloric, nitric, and sulphuric acids, ethyl and methyl alcohols, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, potassium carbonate, salt cake, soda ash, sulphur, benzene, aniline, cottonseed and linseed oils.

the only line of strictly chemical manufacture represented in this table, reports increases of 69.5 per cent in the case of calcium acetate and 34.2 per cent for wood alcohol.

Annual figures for the production, consumption and prices, 1914-1922, of the principal commodities on the chemical market are to be found in the tabulations which follow. These statistics are compiled for the most part from official sources, including the publications of the Census Bureau, U. S. Geological Survey, Bureau of Mines and Bureau of Foreign and Domestic Commerce. Production figures in the case of coal-tar products are taken from the census reports of the United States Tariff Commission, to which credit is cheerfully given for such material as is abstracted from the *Tariff Information Surveys* and the *Summary of Tariff Information.*

TABLE II—THE TREND OF CURRENT PRODUCTION IN CERTAIN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

Production of—	Feb., 1922	Mar., 1922	April, 1922	May, 1922	First 5 Months of 1921	First 5 Months of 1922	Percentage Increase or Decrease in 1922
Acetate of lime, thous. of lb.	7,942	11,134	7,836	7,107	25,088	42,513	+ 69.5
Alcohol (wood), gal.	433,024	587,928	418,271	380,237	1,692,593	2,272,160	+ 34.2
Cement, thous. of bbl.	4,278	6,685	9,243	11,176	33,172	35,673	+ 7.5
Coke, byproduct, thous. of short tons	1,795	2,137	2,227	2,537	9,047	10,599	+ 17.2
Coke, beehive, thous. of short tons	549	732	528	432	3,296	2,737	— 17.0
Cottonseed oil, thous. of lb.	91,321	72,237	27,610	12,389	607,092	304,263	— 49.9
Leather, sole, thous. of sides	1,466	1,473	1,327	1,321	6,704	7,241	+ 8.0
Leather, finished upper, thous. of sq.ft.	70,296	77,510	66,700	67,275	222,779	356,344	+ 60.0
Linseed oil*, thous. of lb.	6,647	7,232	6,069	7,952	38,294	34,357	— 10.3
Metals:							
Pig iron, thous. of long tons	1,630	2,035	2,072	2,307	8,363	9,682	+ 15.8
Steel ingots, thous. of long tons	2,072	2,816	2,794	3,099	9,149	12,420	+ 35.8
Copper, thous. of lb	37,416	61,867	76,601	88,714	326,906	290,434	— 11.2
Zinc, thous. of lb.	45,026	53,064	51,012	54,838	188,004	251,352	+ 33.7
Paper and pulp:							
Wood pulp, chemical, sh. tons	144,568	170,995	147,608	167,197	659,138	666,318	+ 1.1
Newsprint, sh. tons	97,786	117,507	111,861	129,950	528,678	562,812	+ 6.5
All other paper, short tons	404,031	475,353	528,461	589,971	2,075,218	2,720,304	+ 31.1
Petroleum:							
Crude oil, thous. of bbl.	40,814	46,916	44,635	46,473	196,255	221,697	+ 13.0
Gasoline, thous. of gal.	398,223	472,228	472,920	513,659	2,032,050	2,291,703	+ 11.3
Kerosene, thous. of gal.	167,220	178,785	188,809	173,824	835,493	881,555	+ 5.3
Rubber:							
Crude†, thous. of lb.	18,467	26,771	43,407	35,727	124,332	264,105	+112.4
Pneumatic tires, thous.	2,084	2,646	2,401	2,722	6,439	11,908	+ 84.9
Sugar:							
Imports, raw, long tons	448,321	571,836	473,137	446,678	1,520,336	2,254,911	+ 48.3
Meltings, raw, long tons	415,723	535,357	531,962	577,330	1,512,831	2,351,973	+ 55.5

* Shipments from Minneapolis. † Consumption by tire manuacturers.

General Chemicals

Acetic Acid

The significant development in this industry is the remarkable increase in imports, which in 1920 were more than 100 times the imports of 1914. This is due in a large measure to the development of the manufacture of synthetic acid from calcium carbide in Canada. The plant at Shawinigan Falls is reported to have a capacity of about 650 tons per month of 100 per cent acetic acid. Over 90 per cent of the imports in 1919 originated in Canada. The striking decrease in imports in 1921 was due to the accumulation of large stocks in the hands of both consumers and producers. Prices for the 28 per cent acetic acid reached a maximum of 7⅞@8c. per pound late in 1917, but have since fallen to 2¼ cents, as compared with a pre-war price of 1⅜@1⅝c.

PRODUCTION AND IMPORTS OF ACETIC ACID, 1914-1921

Year	Production (Lb.)	Value	Imports (Lb.)
1914	75,303,375	$1,272,294	27,743
1915	....	....	312,850
1916	....	....	504,858
1917	80,000,000	....	201,004
1918	....	....	264,997
1919	56,585,386	2,816,252	1,252,649
1920	....	....	2,862,068
1921	....	....	32,715

PRICES OF ACETIC ACID, 28 PER CENT, AT NEW YORK, 1914-1922

(Dollars per 100 lb.)

	1914	1915	1917	1918
Jan.	1.75-1.90	1.75-2.00	4.50-5.00	5.50-7.00
April	1.50-1.65	1.75-2.00	4.50-5.00	6.00-6.50
July	1.50-1.65	2.50-2.65	5.00-6.00	5.96-6.11
Oct.	1.50-1.65	3.00-3.15	6.50-7.50	4.91-5.16
	1919	**1920**	**1921**	**1922**
Jan.	4.91-5.16	2.75-3.00	3.00-3.25	2.75-3.00
April	3.25-4.00	3.62-4.37	2.50-2.75	2.50-2.60
July	2.75-3.00	3.75-4.50	2.50-2.75	2.25-2.50
Oct.	2.75-3.00	3.75-4.50	2.75-3.00	....

Acetone

Before the war acetone was made exclusively from calcium acetate. War demands as a solvent and for use in the manufacture of the explosive cordite led to the development of several new processes, among them fermentation of corn, molasses and kelp. Acetone was also synthesized from calcium carbide and from the olefine gases obtained in cracking petroleum oils. Except for one producer by the fermentation method other processes have since been abandoned or are continued only on an experimental scale. It is significant to note that present prices are nearly the same as in 1914.

PRODUCTION AND IMPORTS OF ACETONE, 1914-1921

Year	Production (Lb.)	Value	Imports (Lb.)
1914	10,425,817	$1,099,585	2,760
1915	....	....	235,917
1916	....	....	179,497
1917	27,500,000	....	....
1918	....	....	148,082
1919	6,045,914	767,042	443,504
1920	....	....	6,600
1921	....	....	209

PRICES OF ACETONE IN NEW YORK, 1914-1922

(Cents per lb.)

	1914	1915	1917	1918
Jan.	12 -12.5	17-20	22½-23	35 -36
April	10½-11½	21-23	27½-28½	35 -36
July	10½-11½	25-27	32½-33¼	25½-25¾
Oct.	11½-12	30-33	35 -36	25½-25¾
	1919	**1920**	**1921**	**1922**
Jan.	20 -20½	13½-14	13 -13½	12½-12¾
April	15½-16	19 -20	12 -12½	11½-12
July	13½-14	21 -22	12½-13	10 -10½
Oct.	13½-14	15 -18	12½-13	....

Nitric Acid

Production in the war year 1918 reached almost a million tons and in addition but slightly less than 5,000 tons was imported. Exports were also at a maximum in 1918, amounting to about 20,000 tons. Production, imports and exports have all shown marked decreases since the war.

PRODUCTION, IMPORTS AND EXPORTS OF NITRIC ACID, 1914-1921

Year	Production (Short Tons)	Imports (Lb.)	Exports (Lb.)	Value of Exports
1914	78,589	....	Not shown	....
1915	....	356,558	Not shown	....
1916	....	224,699	Not shown	....
1917	602,000	13	Not shown	....
1918	945,000	9,444,028	39,584,858	$23,231,892
1919	19,436	8,000,867	501,568	73,006
1920	....	47,754	716,914	96,109
1921	....	....	267,119*	48,552
1922	....	....	234,736*	27,587

*Fiscal years ending June 30.

PRICES OF NITRIC ACID, 42 DEG. BÉ., NEW YORK, 1914-1922

(Cents per lb.)

	1914	1915	1916	1918
Jan.	4.9-5¼	4.9-5¼	8½-9½	8½-9¼
April	4.9-5¼	4.9-5¼	8½-9½	9¼-9½
July	4.9-5¼	7.9-8¼	8 -8½	8¼
Oct.	4.9-5¼	8½ -9½	7 -7½	8¼-8½
	1919	**1920**	**1921**	**1922**
Jan.	8¼-8½	7½-8	7 -7½	6¼-6½
April	8 -8¼	7½-8	6½-7	6 -6¼
July	7 -8	8 -8½	6¼-6½	6 -6¼
Oct.	7 -8	7¼-7½	6¼-6½	.....

Sulphuric Acid

None other of the strictly chemical industries attains the volume of production which is shown by sulphuric acid. The domestic output reduced to the basis of 50 deg. Bé. acid in 1918 amounted to 7,500,000 tons. Before the war exports were less than one-fifth of 1 per cent of the domestic production. In 1918, however, they amounted to 40,000 tons, valued at $1,250,000. Prices at present are considerably beneath the pre-war level. The 66 deg. acid can be purchased in the New York market for $15 per ton, as compared with $20 in 1914.

PRODUCTION, IMPORTS AND EXPORTS OF SULPHURIC ACID

Year	Producers	Production* Tons	Imports (Lb.)	Exports (Lb.)
1914	194	4,071,566	6,724,911	12,131,750
1915	...	3,868,152	7,382,139	46,771,510
1916	...	5,642,112	6,286,490	82,020,246
1917	221	5,967,551	667,008	58,604,048
1918	...	7,450,000	11,374,400	80,294,643
1919	208	5,402,347	14,746,049	21,295,522
1920	...	5,600,000	10,817,784	28,987,342
1921	...	....	....	18,600,704†
1922	...	....	....	13,979,319†

* Reduced to 50 deg. Bé. basis.
† Fiscal years ended June 30.

PRICES OF SULPHURIC ACID, 66 DEG. BÉ. NEW YORK, 1914-1922

(Dollars per ton)

	1914	1915	1916	1918
Jan.	20-22	20-22	40-50	40-50
April	20-22	20-22	50-60	45-50
July	20-22	25-40	40-45	28
Oct.	20-22	35-50	30-40	28
	1919	**1920**	**1921**	**1922**
Jan.	25	22-25	18-19	17-18
April	17-25	24-25	19-20	17-17.50
July	16-20	24-25	18-20	15-16
Oct.	20-22	22	17-18	....

Ammonium Sulphate

The bulk of the world's trade in ammonia is handled in the form of ammonium sulphate. Prior to the war Germany was the largest producer and annually exported from 40,000 to 70,000 tons m re than she imported. England was second, exporting about three-fourths of her output. The United States ranked third, with France fourth. The tremendous increase in byproduct coke production during and since the war has put the United States on a parity with Germany as a producer of ammonium sulphate. This country has also developed a very important export trade in this commodity, as is evidenced by the fact that during the fiscal year ended June 30, 1922, exports amounted to 168,077 tons. Early in the present year prices were substantially below the 1914 quotations.

PRODUCTION, IMPORTS AND EXPORTS OF AMMONIUM SULPHATE, 1914–1922

Year	Production* (Short Tons)	Value	Imports (Tons)	Exports (Tons)
1914...	186,749	$4,696,590	83,376	Not shown
1915...	225,625	5,648,958	57,048	Not shown
1916...	235,265	8,496,278	19,610	Not shown
1917...	280,396	11,973,468	8,176	Not shown
1918...	378,000	19,637,619	3,983	Not shown
1919...	545,116	20,827,270	2,354	Not shown
1920...	469,463†	....	1,993	Not shown
1921...	303,500	....	......	65,915‡
1922...	....	....	......	168,077‡

* All ammonia compounds figured as sulphate. † Estimated. ‡ Fiscal years ending June 30.

PRICES OF AMMONIUM SULPHATE, NEW YORK, 1914–1922

(Dollars per 100 lb. in single bags)

	1914	1915	1916	1918
Jan..	2.95–3.00	2.50–2.80	4.00	7.25–7.35
April	2.85	3.20	3.70–4.00	7.25–7.35
July.	2.47	3.25	3.40	7.80–7.85
Oct..	2.55–2.80	3.30	4.00	4.75
	1919	1920	1921	1922
Jan..	4.90–5.00	5.00–5.25	3.50–3.75	2.30–2.40
April	4.50	4.50–5.00	2.90–3.00	3.50–3.75
July.	4.65–4.70	5.50	2.60–2.75	3.40–3.50
Oct..	3.75	5.00–5.25	2.20–2.25	....

Arsenic

The maximum annual consumption oı white arsenic in the United States was in 1920, when it was estimated that approximately 15,000 tons was used. In 1921 this dropped to not more than 9,000 tons. It is difficult to estimate the consumption because of its wide variance—from 3,400 tons in 1904 to 15,000 tons in 1921. Prices since 1901 have ranged between 2¾ and 14½c per lb. Prior to 1914 most of the arsenic used in this country was imported. From 1901 to 1910 the United States produced an average of only about 975 tons, as compared with import of 4,235 tons.

PRODUCTION AND CONSUMPTION OF WHITE ARSENIC, 1914–1921

Year	Production (Short Tons)	Value	Imports (Lb.)
1914	4,670	$313,147	3,034,351
1915	5,498	302,116	2,789,531
1916	5,986	555,187	2,458,694
1917	6,151	1,118,313	1,984,480
1918	6,323	1,713,000	3,746,246
1919	[illegible]	....	8,778,218
1920	[illegible]	....	7,479,485
1921	....	....	6,686,570

PRICES OF WHITE ARSENIC, 1901–1922.

(Average price in cents per lb.)

Period	Price	Period	Price
1901–05	2.837	1918	9*
1906–10	3.153	1919	8 –10½
1910–15	2.740	1920	9½–14½
1916	3½– 8	1921	7 –12
1917	8½–15	1922	7 – 8½

* Fixed by U. S. Government.

Barium Chloride

The domestic consumption of barium chloride before the war was supplied almost entirely by Germany, but with the cessation of imports a strong domestic industry was established. Production increased from 2,106 tons in 1915 to 4,870 tons in 1917. Imports fell from 3,000 tons in 1914 to a negligible quantity for the period of 1916 to 1919. They were resumed, however, on a considerable scale in 1920 and 1921. Barium chloride has recently become one of the more temperamental commodities on the chemical market and prices since 1914 have covered the wide range between $32 and $130 per ton.

PRODUCTION AND IMPORTS OF BARIUM CHLORIDE, 1914–21

Year	Production (Lb.)	Imports (Lb.)
1914	....	6,110,386
1915	4,212,000	4,686,029
1916	7,286,000	50
1917	9,740,000	6,614
1918	9,060,000	....
1919	8,743,098	3,290
1920	....	3,190,255
1921	....	4,372,939

PRICES OF BARIUM CHLORIDE, NEW YORK, 1914–1922

(Dollars per ton)

	1914	1915	1916	1918
Jan....	32.50– 33.00	50– 60	110	65– 90
April..	32.00– 32.50	60	140	65– 85
July...	32.00– 32.50	70– 80	110–120	65– 70
Oct....	120.00–130.00	95–100	100–110	65– 70
	1919	1920	1921	1922
Jan....	85–87	90– 95	75–80	52– 53
April..	82–85	150–175	60–65	80– 85
July...	70–80	175–180	59–60	95–100
Oct....	80–85	125–130	43–45	......

Calcium Acetate

During the period between the federal Census of Manufactures in 1914 and 1919, the output of calcium acetate has remained practically stationary. In 1917 the War Industries Board estimated the output at 200,000,000 lb., or about 25 per cent more than the 1919 production. There has been a substantial decrease in our export trade in this commodity, which before the war accounted for at least one-third of the total production. During the fiscal year ended June 30, 1922, exports amounted to 27,606,499 lb. The price range during the period 1914 to 1922 has been between 1½ and 7c. per lb. Early in the present year prices had fallen to 1¾c.

PRODUCTION AND EXPORTS OF CALCIUM ACETATE, 1914–1922

Year	Production (Lb.)	Value	Exports (Lb.)
1914	163,521,577	$2,138,909	68,160,224
1915	....	....	24,673,247
1916	....	....	18,804,972
1917	200,000,000	....	12,959,222
1918	....	....	15,682,813
1919	168,956,000	2,682,232	16,362,929
1920	....	....	23,309,469
1921	....	....	12,845,700*
1922	42,513,000†	....	27,606,499*

*Fiscal years ended June 30. † First 5 months.

PRICES OF ACETATE OF LIME, NEW YORK, 1914–1922

(Dollars per 100 lb.)

	1914	1915	1916	1917
Jan.	1.66⅔	2.00	6.66⅔	3.50
April	1.50	2.66	7.00	4.50
July	1.50	3.75	6.33⅓	5.25
Oct.	1.66⅔	4.50	3.50	6.00
	1918	1920	1921	1922
Jan.	6.00	2.00	2.00	1.75
April	4.00	2.00	1.60	1.75
July	4.00	3.50	2.00	2.00
Oct.	4.00	3.50	2.00	....

Bleaching Powder

Production of bleaching powder fell from 310,380,000 lb. in 1914 to 177,140,000 in 1919. This can be attributed largely to the increasing competition from liquid chlorine. Imports, which in 1914 amounted to almost 50,000,000 lb., fell to less than 1,000 lb. during 1918. There has been some resumption of imports, but even in 1921 when 12,440,906 lb. was received, this was still considerably less than our export trade in this commodity. During 1920 48,826,348 lb. was exported, principally to the Latin-American countries. Present prices are approximately at pre-war levels.

PRODUCTION, IMPORTS AND EXPORTS OF BLEACHING POWDER, 1914–1922

Year	Production (Lb.)	Value	Imports (Lb.)	Exports (Lb.)
1914..	310,380,000	$2,916,225	47,423,651	....
1915..	....	....	18,402,130	....
1916..	....	....	3,289,790	....
1917..	....	....	65,564	....
1918..	....	....	535	13,060,401
1919..	177,140,000	3,418,500	539,596	15,639,918
1920..	....	....	2,474,617	48,826,343
1921..	....	....	12,440,906	18,447,579

PRICES OF BLEACHING POWDER, NEW YORK, 1914–1922

(Dollars per 100 lb.)

	1914	1915	1916	1918
Jan....	1.20–1.30	1.37–1.62	14.00	1.25–3.50
April..	1.20–1.30	1.40–1.50	8.00–8.50	2.25–3.25
July...	1.20–1.30	1.40–1.50	5.50–8.00	2.00–3.25
Oct....	2.25–3.00	2.50–2.75	4.25–6.00	5.50–6.00
	1919	1920	1921	1922
Jan....	2.25–3.50	2.60–2.75	2.75–3.00	2.50–2.60
April..	1.50–2.75	4.00–5.00	2.40–2.60	1.60–1.75
July...	2.00–2.25	6.50–6.75	2.15–2.25	1.60–1.75
Oct....	2.75–3.00	7.50–8.00	2.75–2.80	....

Formaldehyde

Production of formaldehyde more than doubled during the 5-year period 1914 to 1919. In the former year three producers reported an output of 8,426,247 lb., while in 1919 six establishments produced 19,663,753 lb. This increase is probably due to the remarkable industrial development in the manufacture of synthetic resinlike products which are made by the condensation of formaldehyde with hexamethylenetetramine, phenol, or cresol. Imports prior to the war were practically negligible, but in 1920 amounted to 428,444 lb. It is significant to note that recent price reductions have brought the general level down to that which existed prior to 1914, although during the boom of 1920 prices were more than five times present quotations.

PRODUCTION AND IMPORTS OF FORMALDEHYDE, 1914–1921

Year	Production (Lb.)	Value	Imports (Lb.)
1914	8,426,247	$655,174	14,228
1915	....	....	7,700
1916	....	....	79,857
1917	....	....	23,935
1918	....	....	148,798
1919	19,663,753	$3,938,322	502
1920	....	....	428,444
1921	....	....	86,281

PRICES OF FORMALDEHYDE, 40 PER CENT SOLUTION, NEW YORK, 1914–1922

(Cents per lb.)

	1914	1915	1916	1918
Jan.	8½–9½	8½–9½	9½–10	19½–20
April	8½–9½	8½–9½	11 –12½	19 –20
July	8½–9½	8½–9½	13½–14	16½
Oct.	8½–9½	9½–10	10 –11	16½
	1919	1920	1921	1922
Jan.	16½	35–40	18½–18¾	10½–10¾
April	22½–23	58–63	15 –15½	8½– 9
July	20 –22	55–57	13½–14	8½– 8¾
Oct.	22½–23	44–50	12 –12½	......

Copper Sulphate

Blue vitriol, produced largely as a byproduct in copper refining, reached a maximum output in 1916, when 55,622,345 lb. was produced by the refineries. During both 1916 and 1917 the United States enjoyed an unprecedented export trade principally to the countries of southern Europe, where copper sulphate is used as an insecticide in grape culture. Late last year prices were at practically pre-war level, but increases since that time have brought quotations up to about 6⅝c. per lb.

PRODUCTION, IMPORTS AND EXPORTS OF COPPER SULPHATE, 1914-1921

Year	Production (Lb.)*	Imports (Lb.)	Exports (Lb.)
1914	34,411,443	114,730	7,375,775
1915	42,086,107	45,239	10,238,808
1916	55,622,345	184,182	17,978,242
1917	50,007,856	15,952	28,128,190
1918	31,292,490	98,143	15,164,078
1919	30,964,750	120	9,140,673
1920	....	558,450	3,783,409
1921	....	....	4,297,378†
1922	....	....	4,809,948†

* By copper refineries. † Fiscal years ending June 30.

PRICES OF COPPER SULPHATE, NEW YORK, 1914-1922

(Dollars per 100 lb.)

	1914	1915	1916	1918
Jan.	5.00-5.25	4.35-4.55	14.50-15.50	9.50-10.00
Apr.	4.80-5.00	5.75-6.00	17.00-20.00	9.50-10.00
July	4.65-4.75	7.25-7.50	9.00-10.00	9.00- 9.25
Oct.	4.50-4.75	7.25-7.50	8.50-10.25	9.50- 9.75
	1919	**1920**	**1921**	**1922**
Jan.	9.50-9.75	8.25-8.50	6.50- 6.75	5.65- 5.75
Apr.	7.35	8.25-8.50	5.50- 5.75	5.55- 5.65
July	7.65	8.25-8.95	5.75- 6.00	6.50- 6.60
Oct.	8.75-9.00	6.75-7.00	5.00- 5.25	....

Glycerine

The market production of glycerine in 1919 was reported by the Census as follows: Refined glycerine, 64,342,800 lb., valued at $20,724,000, and crude glycerine, 21,304,300 lb., valued at $2,961,600. Pre-war imports of crude glycerine ranged between 13,000,000 and 14,000,000 lb. annually, 50 per cent coming from England and France. Since the war the imports of crude glycerine have fallen off markedly; in 1918 but 1,445,000 lb. was received. The three years 1916, 1917, and 1918 were the boom years for glycerine prices, which in 1918 reached 64c. per lb. as compared with 14⅝c. at present.

PRODUCTION AND IMPORTS OF GLYCERINE 1914-1921

Year	Production* (Lb.)	Imports† (Lb.)	Exports‡ (Lb.)
1914	60,944,799	24,787,000	....
1915	....	15,616,000	....
1916	....	7,026,000	1,022,707
1917	....	2,964,000	13,743,377
1918	....	1,445,000	21,755,400
1919	64,342,800	3,966,308	3,966,308
1920	....	22,413,025	1,737,454
1921	....	2,806,758	2,396,364

* Refined. † Practically all crude. ‡ Practically all refined.

PRICES OF C.P. GLYCERINE, NEW YORK, 1900-1922

(Dollars per 100 lb.)

	1900	1905	1910	1912
Jan.	13.60	12.75	19.00	15.00
April	13.50	12.50	18.75	18.00
July	13.75	11.50	22.00	17.25
Oct.	13.75	11.50	23.00	18.50
	1914	**1915**	**1916**	**1918**
Jan.	19.25	20.00	48.00	64.00
April	19.10	19.50	50.00	62.00
July	21.50	22.00	38.00	59.00
Oct.	20.25	50.00	47.00	25.00
	1919	**1920**	**1921**	**1922**
Jan.	16.00	21.50	14.50	16.00
April	17.00	25.00	14.00	15.50
July	19.00	27.50	12.00	14.75
Oct.	20.00	18.50	13.00	.....

Potassium Carbonate

Imports of crude carbonate of potash formerly averaged about 20,000,000 lb., coming chiefly from Germany. In 1916 they fell to a minimum of 444,241 lb. During the war a small quantity of crude carbonate was produced in this country from wood ashes; the 1917 output was 2,070,000 lb. In 1919 production was up to 48,664,478 lb., valued at $2,299,926. The carbonate is one of the cheapest of the crude potash salts and prior to the war sold for 3c. per lb. During the boom of 1916 prices reached as high as 85c. per lb. for the small quantities that were obtainable. Present quotations are practically at pre-war level.

PRODUCTION AND IMPORTS OF CRUDE CARBONATE OF POTASH, 1914-1921

Year	Production (Lb.)	Value	Imports (Lb.)
1914	....	....	9,046,302
1915	....	....	8,620,504
1916	....	....	444,241
1917	2,070,000	....	1,069,408
1918	1,827,000	$331,000	13,183,741
1919	48,664,478	$2,299,926	1,092,792
1920	976,000	....	16,903,544
1921	....	....	4,048,902

PRICES OF CRUDE CARBONATE OF POTASH, 80 TO 85 PER CENT, 1914-1922

(Cents per lb.)

	1914	1915	1916	1918
Jan.	3-3½	14-14½	45-50	50-55
April	3-3½	15-15½	90	40-45
July	3-3½	20	80-83	38-40
Oct.	6-7	23-24	50	35-38
	1919	**1920**	**1921**	**1922**
Jan.	30-32	23	11-11½	4½-4¾
April	17-18	21-23	7 -8	4½-4¾
July	12-14	20-21	5 -5½	5 -5¼
Oct.	25	19-20	4½-4¾	.....

Potassium Ferrocyanide

In 1914 yellow prussiate of potash was produced in an amount which represented approximately half of the total domestic consumption. In 1918, however, production by three firms amounted to only about a half million pounds, and imports had fallen to 135,000 lb. The reason for this striking decrease both in the production and in the consumption is the substitution of sodium ferrocyanide instead of the potash salt. During the current year yellow prussiate of potash has often been very difficult to obtain, and prices have advanced from 26c. to 33c. per lb. during the last 6 months. The highest war-time price was $1.80, quoted in April, 1916. At that time the red prussiate of potash (potassium ferricyanide) was practically $3 per lb.

PRODUCTION AND IMPORTS OF YELLOW PRUSSIATE OF POTASH, 1914-1922

Year	Production (Lb.)	Imports (Lb.)	Value of Imports
1914	3,204,684	2,986,984	$331,566
1915	....	2,316,738	255,711
1916	....	44,156	31,651
1917	....	41,128	32,251
1918	457,267	134,638	111,096
1919	....	58,003	45,869
1920	....	762,857	105,962
1921	....	447,690	91,447

PRICES OF YELLOW PRUSSIATE OF POTASH, NEW YORK, 1914-1922

(Cents per lb.)

	1914	1915	1916	1918
Jan.	13½	22 -24	90-100	125-130
April	13 -13½	42 -48	175-180	125-127
July	12½-12¾	75 -90	120-130	105-110
Oct.	34 -36	82½-85	65- 75	95-100
	1919	**1920**	**1921**	**1922**
Jan.	75 -80	37 -38	32 -32½	24-24½
April	50 -55	35 -38	26 -27	26-26½
July	25 -30	36 -38	24½-25	33-33½
Oct.	45 -55	36 -38	20 -20½	....

Potassium Hydroxide

There was but one domestic manufacturer of caustic potash prior to the war, and more than half of the domestic consumption was imported from Germany. According to a statement made before the Committee of Ways and Means in 1921, the 1914 output of this firm was reported as 6,504,000 lb. The output in 1919, according to the Census, was 8,358,834 lb. Prices as high as $1 per lb. were noted for the 88 to 92 per cent caustic potash during the second quarter of 1916. At present heavy quotations from Germany have caused prices to sag so that the present scale is around 5½@6c. per lb.

PRODUCTION AND IMPORTS OF CAUSTIC POTASH, 1914-1922

Year	Production (Lb.)	Imports (Lb.)	Value of Imports
1914	6,504,000	6,579,125	$249,030
1915	....	4,993,471	225,002
1916	....	39,770	9,222
1917	....	75,720	33,648
1918	1,984,847	11,732	4,398
1919	8,358,834	466,620	124,563
1920	....	1,712,919	451,274
1921	....	10,910,399	487,182

PRICES OF CAUSTIC POTASH, 88-92 PER CENT, NEW YORK, 1915-1922

(Cents per lb.)

	1915	1916	1917	1918
Jan.	7- 8	65- 70	90-95	83½-85
April	22-25	95-100	88-90	83 -85
July	38-40	83- 90	84-86	80 -82
Oct.	39-41	85- 90	85-90	70 -72
	1919	**1920**	**1921**	**1922**
Jan.	67-70	28- 30	14-14½	6 -6¼
April	50-52	30- 32	9½-10	6 -6¼
July	35-40	28- 30	5 -5½	5¾-6
Oct.	28-35	23- 25	5½-5¾	......

Soda Ash

Next to sulphuric acid, soda ash is probably the most important chemical as regards the volume of production. In 1918 the output amounted to 1,390,628 lb., valued at $35,635,520. Imports are an inconsequential factor and have generally amounted to less than 1 per cent of the domestic production. Since the war the United States has developed an important export trade in soda ash. The record year to date is 1918, when 238,434,992 lb. was exported, principally to Japan, Canada, Sweden and the Netherlands. There has been considerable reduction in the prices that obtained during 1920, but present quotations are much higher than the 1914 and 1915 figures. At that time prices were around 60c. per 100 lb., as compared with $1.75 now.

PRODUCTION, IMPORTS AND EXPORTS OF SODA ASH, 1914-1922

Year	Production (Short Tons)	Value	Imports (Lb.)	Exports (Lb.)
1914	980,224	....	2,228,991	Not shown
1915	1,175,962	....	2,127,542	Not shown
1916	1,194,183	$16,464,774	878,175	Not shown
1917	1,390,625	38,028,000	1,047,295	Not shown
1918	1,390,628	35,635,520	1,514,765	238,434,992
1919	981,054	29,895,343	829,266	100,961,927
1920	1,238,149	38,908,726	1,515,278	166,761,603
1921	....	....	20,344,935	35,042,791

PRICES OF SODA ASH, 58 PER CENT LIGHT, NEW YORK, 1914-1922

(Dollars per 100 lb.)

	1914	1915	1916	1918
Jan.	.57½-.62½	.57½-.62½	1.75-2.00	2.85-3.02
April	.57½-.62½	.57½-.62½	3.50-3.75	2.80-2.85
July	.57½-.62½	.57½-.62½	2.75-3.00	2.00-2.05
Oct.	.57½-.62½	.57½-.62½	3.25-3.50	2.50-2.60
	1919	**1920**	**1921**	**1922**
Jan.	2.00-2.25	2.00-2.10	1.90-2.00	1.80-1.90
April	1.50-2.25	3.25-3.30	1.95-2.10	1.80-1.90
July	1.85-2.15	3.25-3.30	2.15-2.20	1.75-1.80
Oct.	1.90-2.00	2.50-2.60	2.10-2.15	......

Sodium Bichromate

Sodium bichromate and sodium chromate are reported together in both production and import figures. The combined output of these salts in 1914 was 11,824 tons, and in 1918 this had increased to 28,334 tons. The value in the latter year was $9,868,118. Prices in 1914 were fairly stable at 4⅝c. for the bichromate salt. After reaching a peak of 36c. per lb. in 1920, prices have declined until at the present time the salt is obtainable at 7½c. per lb.

PRODUCTION AND IMPORTS OF SODIUM BICHROMATE, 1914–1922

Year	Production* (Tons)	Value	Imports * (Lb.)
1914	11,824	$1,125,398	11,056
1915	....	....	....
1916	....	....	6,154
1917	22,446	9,045,133	....
1918	28,334	9,868,118	27,127
1919	26,526	6,233,566	....
1920	25,973	5,531,954	....
1921	....	....	64,236

* Includes sodium chromate.

PRICES OF SODIUM BICHROMATE, NEW YORK, 1914–1922
(Cents per lb.)

	1914	1915	1916	1918
Jan......	4⅝– 4¾	4⅝– 5¼	25	17 –18
April.....	4⅝– 4¾	4⅝– 5¼	60–70	23 –25
July.....	4⅝– 4¾	10 –11	30 –41	27½–29½
Oct......	4⅞– 5⅛	16	26 –29	22½–24
	1919	**1920**	**1921**	**1922**
Jan......	16½–18	17½–20	9½– 9¾	7¾– 8
April.....	10 –12	34 –36	7½– 7¾	7½– 7¾
July.....	7½– 8	25½–26½	8 – 8¼	7½– 7¾
Oct......	13½–14	17½–19	7¾– 8	......

Glaubers Salt

Glaubers salt is obtained as a by-product in the manufacture of hydrochloric acid and its production is, therefore, largely dependent upon that commodity. In 1914, 34,537 tons was produced with a value of $427,808. In 1918 a maximum output of 50,715 tons was reported. Imports of glaubers salt have never been large and are negligible compared with domestic production. Prior to the war, this salt was quoted at approximately 60c. per 100 lb., but during the 1920 prices as high as $2.50 were heard. At present prices are in the neighborhood of 90c. to $1 per 100 lb.

PRODUCTION OF GLAUBERS SALT, 1914–1921

Year	Production (Tons)	Value
1914	34,537	$427,808
1915	......	....
1916	......	....
1917	47,757	732,403
1918	50,715	1,041,070
1919	47,730	877,060
1920	50,655	990,541

PRICES OF GLAUBERS SALT, NEW YORK 1914-1922
(Dollars per 100 lb.)

	1914	1915	1916	1918
Jan....	.60–.90	.60–.75	.60–.75	.90–1.00
April..	.60–.90	.60–.75	.70–.80	1.50–1.75
July...	.60–.75	.60–.75	.65–.70	1.50–1.75
Oct....	.60–.75	.60–.75	1.25	2.00–2.50
	1919	**1920**	**1921**	**1922**
Jan....	1.75–2.25	1.15–1.50	1.75–2.00	1.30–1.50
April..	1.50–2.00	1.60–1.75	1.75–2.00	.95–1.10
July...	1.00–1.50	2.30–2.45	1.50–1.75	.90–1.00
Oct....	1.25–1.50	2.10–2.50	1.50–1.75	....

Sodium Hydroxide

Caustic soda is second in importance to soda ash among the alkalis. During 1917 and 1918 large quantities of caustic soda were used in the production of synthetic phenol, which in turn was used in the manufacture of the explosive picric acid. The 1918 production was over a half million tons, valued at approximately $32,000,000. In 1917 eight firms used the soda ash method of producing caustic soda, and twenty-eight companies produced caustic soda electrolytically. About 28 per cent of the output in 1917 and 1918 was produced by the latter method. Imports in 1921, the largest on record, amounted to only about 700 tons. Exports, on the other hand, reached a maximum in 1920 of 112,000 tons. Japan, Italy, South America and Canada are the principal customers for American caustic.

PRODUCTION, IMPORTS AND EXPORTS OF CAUSTIC SODA, 1914–1921

Year	Production (Tons)	Value	Imports (Lb.)	Exports (Lb.)
1914	203,391	$6,657,514	665,319	Not shown
1915	287,239	....	444,185	Not shown
1916	391,597	17,426,066	225,189	Not shown
1917	488,056	29,402,689	109,983	Not shown
1918	513,363	31,854,470	2,002	97,378,334
1919	311,388	20,091,978	42,724	164,235,420
1920	382,680	25,894,641	97,798	224,137,406
1921	....	....	1,401,211	49,865,219

PRICES OF CAUSTIC SODA, 76 PER CENT, NEW YORK, 1914–1922
(Dollars per 100 lb.)

	1914	1915	1916	1918
Jan....	2.00–2.25	2.00–2.25	5.50–5.75	6.50–7.00
April..	2.00–2.50	2.25–2.50	6.10–6.25	4.25–4.50
July...	2.00–2.50	2.25–2.50	5.00–5.50	4.00–4.25
Oct....	2.00–2.50	4.00	5.00–5.50	4.50–4.75
	1919	**1920**	**1921**	**1922**
Jan....	4.25–4.90	4.50–4.60	3.75–4.00	3.75–3.80
April..	3.50–4.00	6.75–7.00	3.60–3.70	3.65–3.70
July...	3.33–3.50	6.50–6.75	4.15–4.25	3.50–3.60
Oct....	3.33–3.50	4.00–4.35	4.00–4.10	....

Sodium Ferrocyanide

Sodium ferrocyanide or yellow prussiate of soda is obtained as a by-product in the purification of coal gas. It can also be prepared from sodium cyanide. Production in 1917 was 4,173 short tons, valued at $2,577,667. Since 1917 there has been a consistent increase in the import of yellow prussiate of soda. In 1921 approximately 1,250 tons was imported. This commodity has shown a wide range of prices in recent years. From a pre-war price of less than 10c. per lb. quotations rose until in 1916 as much as $1.25 per lb. was being obtained. Since that time the general trend of the market has been downward, although after reaching a minimum of 12½c. in July, 1921, there was an upward reaction to over 20c. per lb. during 1922.

PRODUCTION AND IMPORTS OF YELLOW PRUSSIATE OF SODA, 1914–1921

Year	Production (Tons) *	Value	Imports (Lb.
1914	6,623	$1,947,582	2,295,714
1915	......	....	1,529,958
1916	......	....	527,130
1917	4,173	2,577,667	175,980
1918	4,525	2,690,110	271,063
1919	3,437	1,346,285	1,299,521
1920	2,930	1,318,049	2,201,662
1921	......	....	2,510,848

* Includes sodium and potassium cyanide in 1914.

PRICES OF PRUSSIATE OF SODA, NEW YORK, 1914–1922
(Cents per lb.)

	1914	1915	1916	1918
Jan.....	10½	14 –16	67½–70	35 –36
April...	9½–9¾	12	1.20–1.25	36½–37
July....	9½–9¾	35 –40	90 –92	60 –63
Oct.....	20–22	41 –45	45 –55	40 –42
	1919	**1920**	**1921**	**1922**
Jan.....	33–34	24 –24½	17 –17½	17 –17¼
April...	17–22	32 –35	13 –13¼	17 –17¼
July....	18–20	25½–27	12½–12¾	21½–21¾
Oct.....	19–20	26 –27	13 –13¼	....

Sulphur

The primary problem of the sulphur industry is to enlarge its market. The potential production of the domestic mines is in the neighborhood of 2½ million tons, whereas the actual production at present is not over one-half of that. Sulphur is in direct competition with pyrites in the acid-making industry and over one-half of the one million tons of sulphur sold in the United States in 1920 was used in the manufacture of sulphuric acid. A consideration of the following tables will show that during the last 10 years production has been considerably in excess of domestic shipments. There is at present an accumulation of approximately two million tons of sulphur, mined and ready for the market. Except for a short period during 1918 and 1919 the price of sulphur has been remarkably stable. At present quotations of $18 per ton f.o.b. New York are considerably under the pre-war figures.

PRODUCTION AND CONSUMPTION OF SULPHUR, 1909–1920
Production in tons

Year	World	United States	Domestic Shipments	Gross Value
1909	804,690	273,983	258,283	$4,783,000
1910	775,286	247,060	250,919	4,522,000
1911	764,358	205,066	253,795	4,573,000
1912	773,436	287,773	305,390	5,289,000
1913	793,645	491,080	319,333	5,614,000
1914	863,143	417,690	341,985	6,214,000
1915	846,412	520,582	293,803	3,955,000
1916	1,199,842	649,683	766,835	12,247,000
1917	1,548,023	1,134,412	1,120,378	23,987,000
1918	1,655,629	1,353,525	1,266,709	27,868,000
1919	(a)	1,190,575	678,257	10,252,000
1920	(a)	1,255,249	1,517,625	(a)

(a) Statistics not available.

PRICES OF CRUDE SULPHUR, NEW YORK, 1914–1922
(Dollars per ton)

	1914	1915	1916	1918
Jan....	22–22.50	22–22.50	22–22.50	35–40
April..	22–22.50	22–22.50	29–30	Nominal
July...	22–22.50	22–22.50	35	Nominal
Oct....	22–22.50	22–22.50	35	30
	1919	**1920**	**1921**	**1922**
Jan....	28–35	22	16–20	18–20
April..	28–35	22	20–22	18–20
July...	28–35	22	20–22	18–20
Oct....	28–32	16–20	18–20	....

Coal-Tar Products

Aniline Oil

Aniline oil occupies the same position of relative importance among the coal-tar intermediates as does sulphuric acid among the general chemicals. It is used in the production of a wide range of important dyestuffs. In 1920 the output of this intermediate alone amounted to 39,234,186 lb., valued at almost $11,000,000. The marked decrease that occurred in dye production during 1921 is well evidenced by the fact that the production of aniline oil shows a decrease of 86 per cent from that of 1920. The production of aniline salts (aniline hydrochloride and aniline sulphate) fell from 2,024,956 lb. in 1920 to 366,533 lb. in 1921. Imports of aniline oil have been of practically no significance since 1914. Prices have followed an unusually wide range, from 10c. per lb. in 1914 to as much as $1.10 per lb. during the shortage of 1915 and 1916. Present prices are around 15c. per lb.

PRODUCTION AND IMPORTS OF ANILINE OIL, 1914-1921

Year	Number of Producers	Production Lb.	Value	Imports
1914	1	.........*	....	1,444,772
1917	23	28,806,524	$6,758,535	....
1918	16	24,102,129	6,572,684	....
1919	14	24,345,786	5,932,536	....
1920	14	39,234,186	10,923,648	....
1921	9	5,259,598	1,161,381	11,243

* Made by a single company on a scale below domestic consumption.

PRICES OF ANILINE OIL, NEW YORK, 1914-1922
(Cents per lb.)

	1914	1915	1916	1918
Jan.	10¼	60	68	23½
April	10½	110	65	25¾
July	11	90	39	27
Oct.	43½	70	25	28
	1919	1920	1921	1922
Jan.	27	34	22	17½
April	24	34	20	16½
July	22	35	20	14
Oct.	32	32	17½-18	..

Benzene

A striking increase in production has been noted in the case of benzene, the most important of the so-called coal-tar crudes. In 1914 the production of crude light oil was 8,464,274 gal., equivalent to a production of about 4½ million gallons of benzene. In 1918 44,804,900 gal. of benzene was produced in this country. Much of this, however, was used as raw material for explosives. In 1920 the Geological Survey reports on the production as follows: Crude, 8,747,572 gal., refined, 16,977,556 gal., and motor fuel 57,645,462 gal. The latter varies in benzene content from 50 to 100 per cent. It is evident from these figures that the productive capacity for benzene is far in excess of that required for the manufacture of dyes or other chemical products. Directly following the armistice prices of benzene dropped to less than pre-war, but since that time have increased until at the present writing benzene is quoted at approximately 29c. per gal.

PRODUCTION OF BENZENE, 1916-1921

Year	From Byproduct Coke Ovens (Gal.)	Value	From Other Sources (Gal.)	Value
1916	21,079,500	$13,159,374	....	....
1917	36,804,228	16,576,865	3,082,774	$1,536,495
1918	44,804,900	12,341,779	4,420,010	1,281,803
1919	44,697,615	7,776,669	1,826,373	560,547
1920	87,370,390*	27,142,754	875,561	287,586
1921	....	....	2,171,631	463,205

* Includes 57,645,462 gal. of motor fuel containing 50 to 100 per cent of benzene.

PRICES OF BENZENE, C.P., 1914-1922
(Cents per gal.)

	1914	1915	1916	1918
Jan.	23	27	70	35
April	23	29	70	28½
July	28	55	60	22
Oct.	29	60	55	22
	1919	1920	1921	1922
Jan.	22	30	30	27
April	20	31	27	29
July	24	37	27	29
Oct.	36	37	27	..

Beta Naphthol

Technical beta naphthol is the most important of the napthalene derivatives. The output in 1921 was 2,959,049 lb.—a 75 per cent decrease from that of the previous year. The maximum production in 1920 corresponds with the period of greatest output for the industries using para reds and other important colors in which this intermediate is used. The price of technical beta naphthol prior to the war was usually less than 10c. per lb. Prices were over ten times this figure in 1915 and 1916, but with the increasing production in 1918, 1919 and 1920 prices have shown a rather consistent decline and at present the quotations are in the neighborhood of 23c. per lb.

PRODUCTION OF BETA NAPHTHOL, TECHNICAL, 1917-1921

Year	Number of Producers	Production (Lb.)	Value	Value per Lb.
1917	16	5,913,846	$3,950,166	$0.66
1918	10	5,117,683	3,009,773	.59
1919	11	4,835,778	2,365,804	.49
1920	6	11,920,714	5,592,007	.47
1921	7	2,959,049	1,154,033	.39

PRICES OF BETA NAPHTHOL, TECHNICAL, 1917-1922
(Dollars per lb.)

	1914	1915	1916	1918
Jan.	.10	.85	1.30	.65
April	.9⅞	.85	1.25	.65
July	.10½	1.01½	1.16½	.65
Oct.	.30	1.16½	1.10	.61½
	1919	1920	1921	1922
Jan.	.60	.55	.38	.30
April	.55	.65	.33	.28
July	.50	.88	.38	.23
Oct.	.50	.75	.32	....

Naphthalene

It is difficult to give reliable figures for the production of naphthalene, due to the fact that it is produced from several different sources and in at least two grades. The figures in the accompanying table are those reported to the United States Tariff Commission as the production of refined naphthalene (solidifying at 79 deg. C. or above). The 1921 output of 13,183,142 lb. is a decrease of 55 per cent from that of 1920. It should be pointed out, however, that these figures do not include the output of naphthalene at coke ovens, data for which are usually collected by the Geological Survey. An idea of the extent of the production of crude naphthalene in the United States during 1918 may be gained from the following figures reported by the Survey: From tar distillers, 40,138,092 lb., valued at $1,281,440; from coke ovens, 10,614,799 lb., valued at $292,868; from gas houses, etc., 428,088 lb., valued at $11,558. This is a total of 51,180,979 lb., valued at $1,585,866. Imports during the 1914 fiscal year were 3,880,108 lb., valued at $70,428. Since the passage of the tariff act of 1916, imports of refined naphthalene have been less than 1 per cent of the domestic production.

PRODUCTION OF NAPHTHALENE, REFINED FLAKE, 1917-1921

Year	Number of Producers	Production (Lb.)	Value	Value per Lb.
1917	12	35,342,911	$2,334,302	$0.07
1918	10	28,112,165	2,162,168	.08
1919	7	17,625,235	1,160,815	.07
1920	9	30,230,734	2,308,536	.08
1921	9	13,183,142	740,955	.06

PRICES OF NAPHTHALENE, REFINED FLAKES, NEW YORK, 1914-1922
(Cents per lb.)

	1914	1915	1916	1918
Jan.	2¾	3½	13½	10
April	2¾	8½	13¾	10½
July	2¾	15	8¾	9
Oct.	3¼	12½	8	9
	1919	1920	1921	1922
Jan.	9	8	8	7
April	7	10	8½	6½
July	6½	16	7	6½
Oct.	6	13	6½	..

Paranitraniline

The output of this important intermediate used in the manufacture of para reds and various color lakes reached a maximum in 1920 of 2,138,492 lb., valued at $2,500,000. The 1921 output showed a decrease of 61 per cent as compared with the previous year. The pre-war price of paranitraniline was 16c. per lb., but for 6 years following the cutting off of German imports prices were well over $1 per lb. During 1921, however, there was a gradual and consistent lowering of prices.

PRODUCTION OF PARANITRANILINE, 1917-1921

Year	Number of Producers	Production (Lb.)	Value	Value per Lb.
1917	9	1,724,008	$1,952,229	$1.13
1918	9	1,320,064	1,722,319	1.30
1919	8	1,310,658	1,388,627	1.06
1920	6	2,138,492	2,503,886	1.17
1921	9	621,559	526,403	.85

PRICES OF PARANITRANILINE, 1914-1922
(Dollars per lb.)

	1914	1915	1916	1918
Jan.	.16	1.25	1.45	1.15
April	.16	1.25	1.48	1.30
July	.16	1.25	1.36½	1.55
Oct.	.50	1.28	1.35	1.65
	1919	1920	1921	1922
Jan.	1.75-2.00	1.30	.93-1.00	.77-.80
April	1.25-1.50	1.45	.85-.90	.75-.77
July	1.00-1.25	1.45	.85-.90	.72-.75
Oct.	.95-1.00	1.20	.79-.82	......

Phenol

Phenol is another commodity which offers difficulties to the statistician, largely because of grades and varying sources of production. The years 1917 and 1918 showed enormous outputs of phenol, which, of course, was used almost entirely in the production of explosives. Much of the 106,794,277 lb. produced in 1918 came from synthetic phenol plants operating under government contracts. With the signing of the armistice, large stocks of government phenol were placed on the market. Approximately 25,000,000 lb., or nearly three times the normal annual consumption, was offered for sale. Naturally, this had a most depressing effect both on production and marketing of this article. The 1919 output was only 1,500,000 lb., valued at about 10c. per lb. There were but two producers during 1920, and their production could not be published. In 1921, the output had fallen further to less than a third of a million pounds.

PRODUCTION OF PHENOL, U.S.P. AND TECHNICAL, 1917-1921

Year	Number of Producers	Production (Lb.)	Value	Value per Lb.
1917	15	64,146,499	$23,715,805	$0.37
1918	17	106,794,277	37,270,284	.35
1919	6	1,543,659*	155,624	.10
1920	2	....	....	....
1921	3	292,645	41,617	.14

* Cessation of military demand and disposal of army surplus.

PRICES OF PHENOL, U.S.P., NEW YORK, 1914-1922
(Cents per lb.)

	1914	1915	1916	1918
Jan.	7¾	88½	1.31½	54
April	7¾	1.21½	.79½	52
July	21½	1.46¾	58	44
Oct.	44¾	1.51½	55	41
	1919	1920	1921	1922
Jan.	30-35	14	9	11½
April	10-12	20	11	11½
July	10-12	18	11	15
Oct.	12-14	12	8½	..